FM 6-40-3
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FM 6-40-3

REFERENCE

FIELD MANUAL

RESCINDED Per DA PAM 25-30; 31 Mar 87

OPERATION OF THE GUN DIRECTION COMPUTER M18, CANNON GUNNERY APPLICATION

This copy is a reprint which includes current pages from Changes 1 and 2.

HEADQUARTERS, DEPARTMENT OF THE ARMY

AUGUST 1970

Reference

Change

No. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *22 April 1977*

OPERATION OF THE GUN DIRECTION COMPUTER

M18, Cannon Gunnery Application

FM 6-40-3, 26 August 1970, is changed as follows:

1. Remove old pages and insert new pages as indicated below. New or changed material is indicated by a star in the margin of the page.

Remove pages	Insert pages
i, ii	i, ii
E-1	E-1, E-2
	G-1 through G-71
	H-1 through H-33

2. The word "he" as used in this publication is intended to include both the masculine and the feminine genders. Any exceptions to this will be so noted.

3. These transmittal sheets should be filed in front of the manual for reference purposes.

By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

Official:
PAUL T. SMITH
Major General, United States Army
The Adjutant General

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Active Army, USAR, and ARNG: To be distributed in accordance with DA Form 12-11A, Requirements for Operation of the Gun Direction Computer, M18, Cannon Gunnery Application (Qty rqr block no. 48).

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FIELD MANUAL No. 6-40-3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., *26 August 1970*

OPERATION OF THE GUN DIRECTION COMPUTER M18, CANNON GUNNERY APPLICATION

* This manual supersedes FM 6-3-1, 14 June 1968.

CHAPTER 1

GENERAL

Section I. PURPOSE AND SCOPE

1-1. Purpose

This manual is a guide for training field artillery personnel in the operation of the M18 gun direction computer (FADAC).

1-2. Scope

a. This manual covers the operation of the M18 gun direction computer in the cannon application with *Revision 4* program tapes. Appendix A is a list of references. Appendix B is a complete set of instructions for the preparation of the computer meteorological message tape for training. Appendix C presents ammunition reference data, and appendix D presents sample problems. The cannon program tapes which are needed for use with this manual are listed in appendix E.

b. Users of this manual are encouraged to submit recommended changes and comments to improve the publication. Comments should be keyed to the specific page, paragraph, and line of text in which the change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commandant, U.S. Army Field Artillery School, Fort Sill, Oklahoma 73503.

c. This manual is in consonance with NATO STANAG 4082 and can be used only with Revision 4 Cannon Program Tapes.

1-3. Introduction

a. The M18 gun direction computer (FADAC) is the primary means by which a cannon battalion or battery fire direction center solves the gunnery problem. Use of this high-speed digital computer significantly increases accuracy and flexibility in the delivery of artillery fires. The manual solution to the gunnery problem involves recognized inaccuracies which result from the use of assumed or approximate data and which must be accepted for expediency. Therefore, the gun data calculated by manual means will not necessarily agree with that produced by the M18 gun direction computer. The magnitude of variance will depend upon the factors that affect the accuracy of the manually calculated data or upon the accuracy of the data entered into the computer. If all the ballistic variables are accurate and correctly inserted into the computer, the FADAC will determine more accurate gun data than can be determined manually. Conversely, if inaccurate or erroneous data are entered or if improper procedures are used, the FADAC will produce poor results.

b. The FADAC operator should be thoroughly trained in field artillery gunnery fire direction techniques and in the operation of the computer. Supervisory personnel must insure that correct data are entered into the computer and that the operator uses correct procedures. Checks must also be made to insure that obsolete data are not being used. All data entered by an operator can be checked by use of recall procedures.

Section II. PERSONNEL REQUIREMENTS

1-4. General

The M18 gun direction computer (fig 1-1) is authorized for issue to all cannon and rocket field artillery units and to the survey information center (SIC) of each division and corps artillery.

1-5. Operator Personnel

a. The assigned personnel in both the battery and battalion fire direction centers operate the computer and its associated and auxiliary equipment. The minimum number of personnel required for sustained computer operation is four:

two computer operators and two generator operators. Distribution of duties for fire direction center personnel is shown in chapter 3.

b. Even though the M18 computer is used as the primary means for generating firing data, a manual system to supplement the gun direction computer is also required. The manual operation and the computer operation are normally conducted from the same fire direction center (FDC). Communications requirements and systems remain unchanged.

c. If the computer or the generator malfunctions during a mission, the vertical control operator (VCO), the computer operator (HCO), and the computers must be prepared to complete the mission manually. The requirement for batteries to be capable of assuming the battalion role remains unchanged.

1–6. Duties of Personnel

★*a. Computer Operator.* The computer operator is responsible for the emplacement, march order, operation, and operator maintenance of the computer and its associated equipment. His duties are to—

(1) Insure that the correct procedures are followed in setting up the computer and its associated equipment.

(2) Insure that the correct procedures are followed in the operation and maintenance of the equipment.

(3) Transmit and record data in accordance with the unit standing operating procedures.

(4) Report deficiencies and shortcomings of the computer and computer equipment to the chief of section.

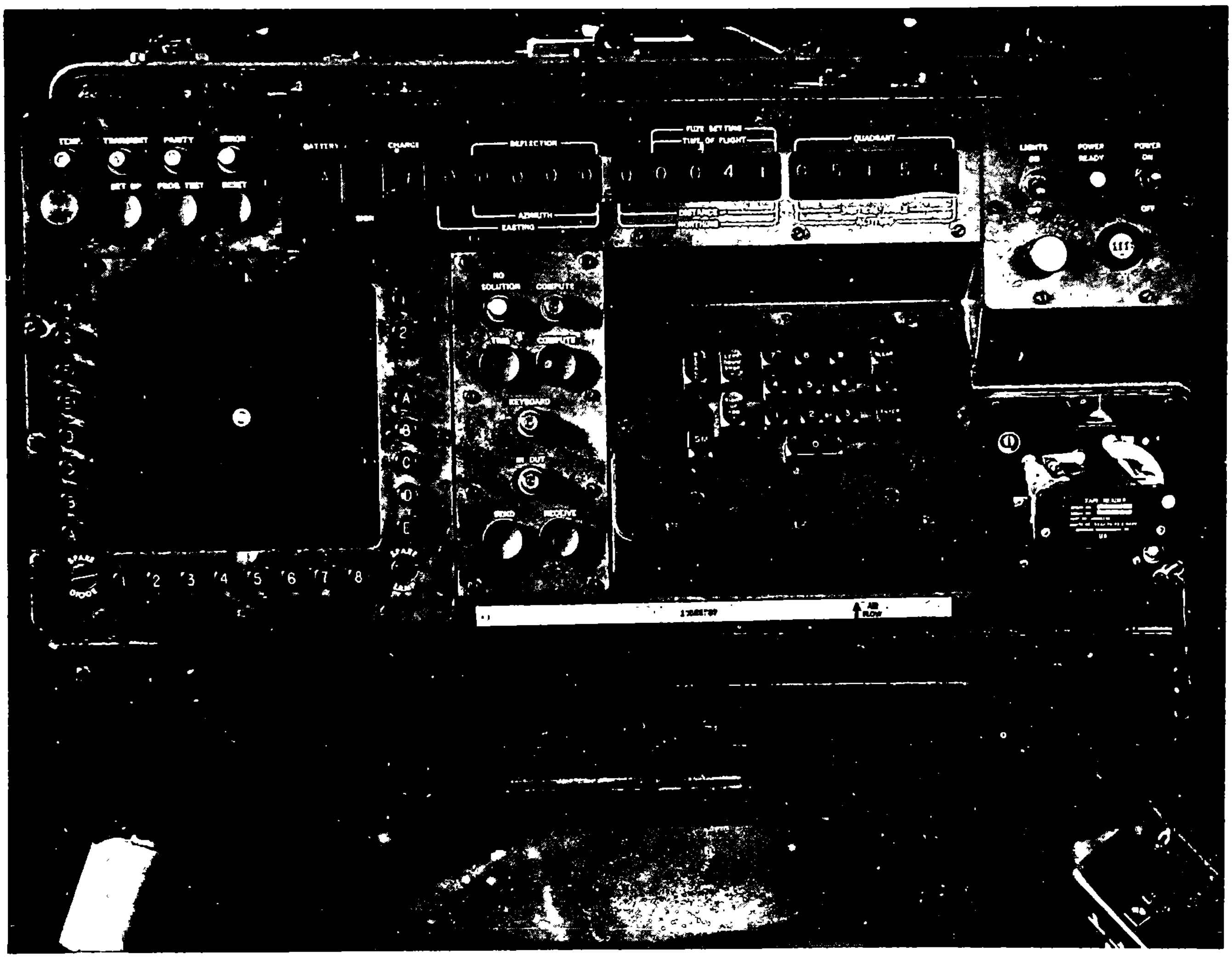


Figure 1–1. M18 gun direction computer.

(5) Perform operator maintenance at regular intervals. Perform only the maintenance authorized in the maintenance allocation charts in TM 9-1220-221-20/1. For other details, read chapter 3, TM 9-1220-221-10.

★*b. Generator Operator.* The duties of the generator operator are normally performed as additional duties by a member of the fire direction center. In addition to his regular duties, the person assigned the duties of the generator operator is responsible for—

(1) The proper emplacement of the generator to include grounding.

(2) Starting, stopping, and monitoring the operation of the generator on a standby basis.

(3) Insuring that the generator is providing the proper output.

(4) Performing operator maintenance and reporting discrepancies and shortcomings of the generator in maintenance to the chief of section.

(5) Maintaining the prescribed records on generator operation.

CHAPTER 2

EQUIPMENT

NATO STANAG 4082

Section I. DESCRIPTION

2-1. General

★*a*. The gun direction computer M18 (fig 1-1) is a general purpose, electronic, solid-state, digital computer with nonvolatile rotating disc memory. It is especially designed to solve the gunnery problem, however, as a general purpose computer, it will perform any computational task for which a program has been written and inserted into memory. It is limited only by the size of the rotating magnetic disc memory of 8,192 words. In the cannon application, the computer will compute the optimum charge, deflection, time of flight or fuse setting, and quadrant elevation. In addition to computing these firing data, it will compute four types of survey problems: traverse, zone-to-zone transformation, intersection, and observer orientation. Solutions are displayed on Nixie tubes on the front panel of the computer.

b. Programs are coded on punched paper tape and are inserted into memory by the signal data reproducer (SDR), an item of equipment designed for this purpose. Once the program has been loaded, it cannot be changed by normal operator actions. The operator enters information required in the solution of problems by using an input selection matrix and a keyboard or by using a mechanical tape reader.

2-2. Components and Associated and Auxiliary Equipment

a. The computer is of modular construction, consisting of four major components—the power supply chassis, the magnetic disc memory, the control panel assembly, and the circuit boards. The computer is housed in a watertight case with removable front and rear covers. Computer parts are cooled by two blowers which draw air through replaceable filters and exhaust it through louvers in the rear of the computer.

★*b*. Associated equipment consists of a computer table with an integral power connection panel, a power cable and reel assembly, and a 3-kilowatt (kw), 120/208-volt, 400 hertz, 3 phase, 4-wire generator.

c. Auxiliary equipment consists of the signal data reproducer AN/GSQ-64 and the computer logic unit test (CLUT) set AN/GSM-70.

d. Complete nomenclature and technical characteristics of the computer and related equipment and detailed information on the operation of the computer are presented in the references listed in appendix A.

Section II. PREPARATION FOR OPERATION AND MARCH ORDER

2-3. General

Preparing the gun direction computer M18 for operation or for traveling requires a minimum of four men. The computer weighs approximately 210 pounds and should be handled with care to prevent damage to the equipment or injury to personnel. The computer table weighs 58 pounds, and at least two men are required to set up or march order the table.

2-4. Preparation for Operation

a. If the computer is not mounted in a vehicle, it is prepared for operation as follows:

(1) Turn the computer table upside down and release the screw-lock fasteners on the legs.

(2) Unfold and extend each leg so that the height of the table is comfortable for the operator and the tabletop is level.

(3) Secure each leg in position by tightening the locking ring, and place the table in an upright position.

(4) Have two men place the computer on the table.

(5) Depress the core of the pressure release valve and allow the pressure in the case to equalize.

(6) Remove the front and rear covers.

(7) Fasten the four latches on the table over the four hooks on the computer case.

(8) Remove the cap from receptacle J11 and connect cable P11 from the table to receptacle J11.

(9) Connect the power cable to receptacle J5 on the table and insure that the circuit breaker is in the OFF position.

(10) Start the generator and insure that it is producing the correct voltage.

(11) Check the air intake beneath the control panel of the computer for obstructions and insure that the air will flow freely into the computer.

(12) Place the circuit breaker in the ON position.

(13) Turn the POWER switch on the power panel to the POWER ON position. When the POWER READY indicator lights, the computer is ready to operate.

b. When the computer is mounted in a vehicle, only the procedures in *a*(1) through (13) above will be applicable.

c. For further details on handling the equipment, see TM 9–1220–221–10/1.

2–5. March Order

a. General. If the computer is not mounted in a vehicle, it is prepared for traveling as follows:

(1) Move the POWER switch and the circuit breaker to OFF positions.

(2) Stop the generator and disconnect the power cable; replace the cable on the cable and reel assembly.

(3) Disconnect all other cables from the computer and replace the front and rear covers.

(4) Unfasten the four latches and remove the computer from the table.

(5) Secure the plug of the computer power cable to the clamp under the table and make sure that all receptacle covers are in place.

(6) Turn the table upside down and release the telescoping portion of each leg by turning the locking ring counterclockwise.

(7) Retract and fold the legs.

(8) Place the computer, the field table, and the cable and reel assembly in the transport vehicle.

b. Mounted Equipment. To march order equipment that is mounted in a vehicle, perform *a*(1) and (2) above.

Section III. OPERATOR CONTROLS

2–6. General

The M18 gun direction computer is controlled through the use of buttons, switches, and keys. All controls and indicators are located on the front panel or near the front of the computer within easy reach of the operator.

2–7. Control Panel Description

The computer control panel assembly (fig 2–1) consists of seven small panels. Each of these panels may be considered a functional area, and each is identified according to the principal use of the panel. The seven panels are as follows:

a. Power Panel. The power panel (fig 2–2), on the upper right section of the control panel, has a toggle switch to turn the computer on and off, a toggle switch to control two night lights, a POWER READY indicator, and a time meter to indicate the cumulative hours of operation.

b. Trouble Indicator Panel. The trouble indicator panel (fig 2–3), in the upper left corner of the control panel, has four trouble indicators, a night light, and three buttons—SET UP, PROG TEST, and RESET.

c. Operator Panel. The operator panel (fig 2–4) in the lower center of the control panel has four buttons—TRIG, COMPUTE, SEND, and RECEIVE. The panel also includes four indicators which show the operator when the computer is in the compute or input-output mode or when a problem has no solution.

d. Matrix Panel. The matrix panel (fig 2–5)

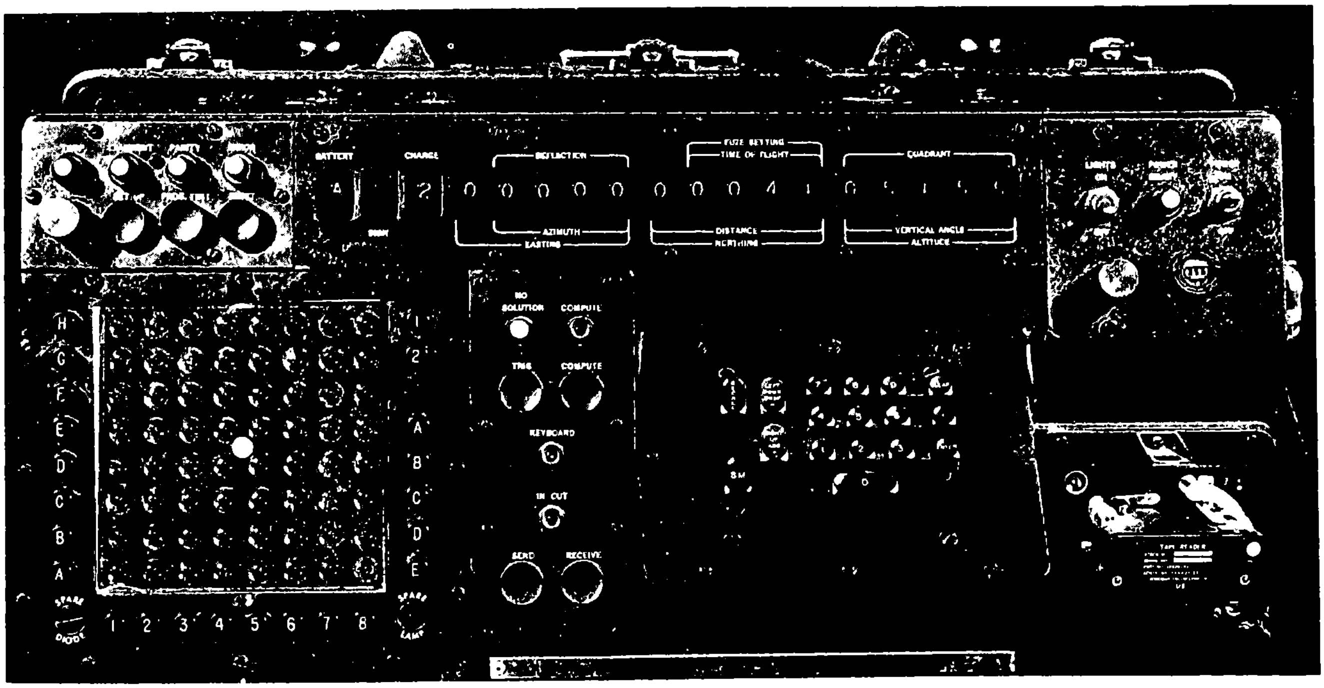


Figure 2-1. Computer control panel.

on the left side of the control panel, is a selection device which allows the operator to control the data that are entered, recalled, or computed in the solution of a problem. Details describing the use of the matrix panel are contained in table 2-1.

e. Keyboard. The keyboard (fig 2-6) on the right of the operator panel, consists of control, sign, and digital keys which are used to enter numerical data.

★*f. Mechanical Tape Reader.* The mechanical tape reader (fig 2-8), in the lower right portion of the control panel, is a mechanical device capable of reading five-hole punched paper tape as input data. Its primary function is to read the meteorological message tape.

★*g. Display Panel.* The display panel (fig 2-7), located in the upper center section of the control panel, is the primary output device of the M18 in the cannon application. It consists of a series of Nixie tube indicators which provide a display of numerical, sign, and designation information as it is entered in the computer and an output display of the problem solution. In most instances, the data entered through the keyboard are displayed on this panel and then are erased when the ENTER key is depressed. The panel is divided into six windows which contain the Nixie indicator tubes that display the firing data solution.

2-8. Functions of Controls and Indicators

The function of each control and indicator on the computer control panel (fig 2-1) is described below:

a. POWER ON-OFF Switch. The POWER-ON-OFF switch is a momentary-contact center-return switch. When the switch is in the ON position, the power supply, blowers, and memory are energized. When the switch is in the OFF position, the computer is de-energized.

b. POWER READY Indicator. The POWER READY indicator lights approximately 20 seconds after the computer is turned on. The indicator blinks when the computer is in the marginal test mode or when the lower blower motor is not operating. The lower blower motor does not operate when the back cover is left on the computer. Therefore, this indicator will blink when the back cover is left on the cold weather operations. If the indicator blinks when the cover has been removed and the MARGINAL TEST switch is off, a malfunction of the lower blower is indicated.

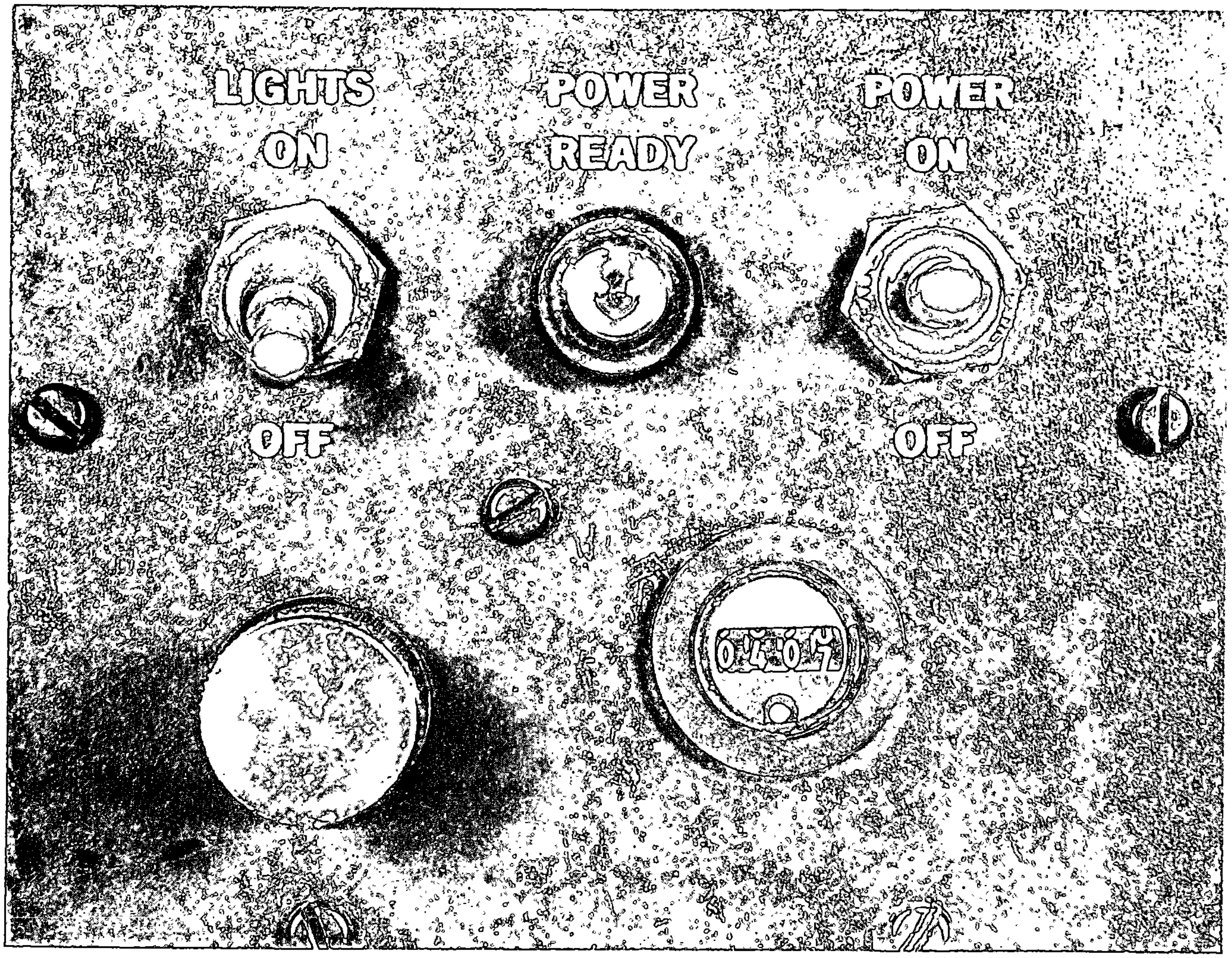


Figure 2-2. Power panel.

c. LIGHTS ON-OFF Switch. The LIGHTS ON-OFF switch controls the panel lights for night operation.

d. Time Meter. The time meter records the cumulative hours the computer has been in operation.

e. TEMP Indicator. The TEMP indicator lights when the internal operating temperature is correct. The indicator blinks when the operating temperature is not correct.

f. TRANSIENT Indicator. The TRANSIENT indicator lights when the line voltage is correct. The indicator blinks when the power supply voltage fluctuates or approaches operating limits.

g. PARITY Indicator. The PARITY indicator is normally lighted. It blinks when an error in internal data transfer occurs during computation or when incorrect data are transferred from an input device to memory or from memory to an output device.

h. ERROR Indicator. The ERROR indicator is normally lighted. It blinks when there is an internal overflow or an error verification. Blinking of the indicator may be caused by the entry of a number too large for the computer.

i. PROG TEST Button. When the PROG TEST button is depressed and the numerical key 1 or 2 is depressed, the computation of a stored test begins. The validity of the program entered in memory is tested. If the 3 key is depressed, the Nixie tubes will be tested.

j. SET UP Button. The SET UP button is used in the cannon program to associate the program information on the caliber and type of weapon with selected batteries. This button is controlled by an interlock matrix position (E–2, SET UP). When the SET UP button is depressed, all constants pertaining to a given caliber are set to standard.

k. RESET Button. The RESET button is depressed to terminate the mode; for example, to halt the computations being made. This button will also terminate blinking of the PARITY, ERROR, or TRANSIENT indicator if the indicated malfunction is not recurring.

l. COMPUTE Indicator. The COMPUTE indicator glows steadily while the computer is in the compute mode.

m. TRIG Button. Depressing the TRIG button causes the computer to apply a trigonometric shift to a previously computed trajectory solution. The computer provides the solution without simulating the trajectory as described in

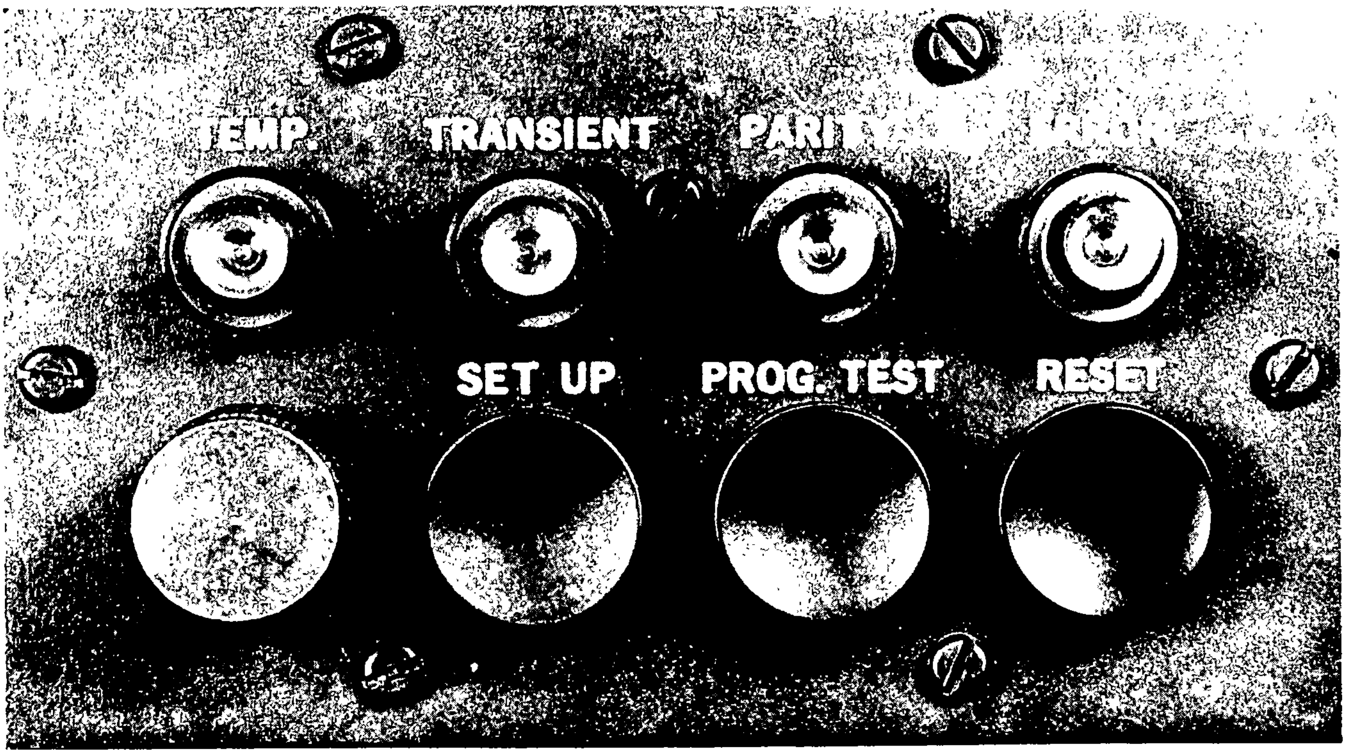


Figure 2-3. Trouble indicator panel.

paragraph 2-26. It provides a rapid solution during an adjustment of a fire mission and safeguards against its use are limited as follows:

(1) If a ballistic trajectory has not been computed subsequent to END OF MISSION instructions, depressing the TRIG button automatically causes a trajectory solution.

(2) If changes are made in input data, such as muzzle velocity, powder temperature, or projectile weight, a trajectory solution will be performed automatically.

(3) If an observer shift greater than ±400 meters in range or deviation, or ±50 meters in height is made, depressing the TRIG button automatically causes a trajectory computation. However, cumulative shifts greater than these are not automatically controlled.

n. COMPUTE Button. Depressing the COMPUTE button causes the computer to compute the trajectory for the ballistic problem only.

o. NO SOLUTION Indicator. The NO SOLUTION indicator is normally lighted and blinks if the data entered for a particular problem produces no solution. A numerical display defines the cause (para 2-24).

p. KEYBOARD Indicator. The KEYBOARD indicator lights when a keyboard entry is required.

q. IN-OUT Indicator. The IN-OUT indicator lights when information is being transferred to or from an input-output device. This indicator as well as the KEYBOARD indicator must light before the keyboard is used to enter data.

r. SEND Button. Depressing the SEND button initiates computation of the chronograph extrapolation program.

s. RECEIVE Button. Depressing the RECEIVE button erases the zeros that precede the displayed gun data and recalls the last gun data computed.

2-9. Keyboard Assembly

a. SM and RECALL Keys. Depressing the SM (sample matrix) key causes the computer to use the instructions in the portion of the program indicated by the matrix position selected. Normally the instructions require a keyboard entry, in which case the KEYBOARD indicator will light. Depressing the RECALL key causes the computer to recall from memory the data indicated by the matrix position selected.

b. LEFT, DOWN, DROP, - (MINUS) Key. Depressing the LEFT, DOWN, DROP, - key causes a negative sign to be associated with the numerical value entered through the keyboard.

c. RIGHT, UP, ADD, + (PLUS) Key. Depressing the RIGHT, UP, ADD, + key causes a

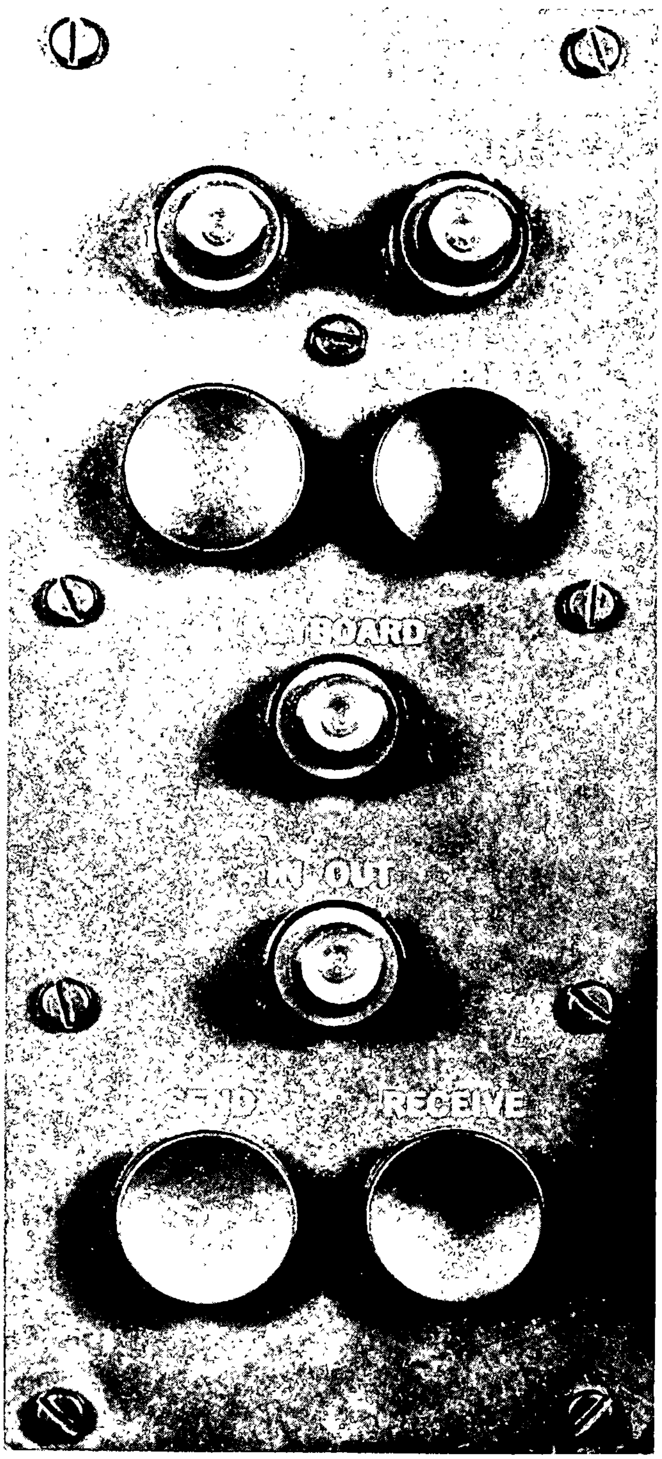


Figure 2–4. Operator panel.

positive sign to be associated with the numerical value entered through the keyboard.

d. The Numerical Keys and the Decimal Point Key. The numerical keys (0, 1, 2, 3, 4, 5, 6, 7, 8, and 9) and the decimal point key (.) are used to enter numerical values, including decimal points. The keys are interlocked to prevent an error from being made by inadvertently depressing two keys simultaneously. As each key is depressed, the numerical value entered is displayed on the display panel.

e. CLEAR and ENTER Keys. The CLEAR key is used to clear an erroneous keyboard input and to erase the display before the value has been permanently entered into memory. After the CLEAR key has been depressed, the correct information can be entered without depressing the SM key again. The ENTER key is used to enter the values displayed into the memory of the computer. An entry error that is discovered after the ENTER key has been depressed can be corrected by reselecting the matrix position, depressing the SM key, and typing the correct data on the keyboard. If an erroneous entry is discovered after the TRIG or COMPUTE button has been depressed, care must be taken in making the appropriate correction. For example, in an adjust-fire mission if an erroneous observer correction is detected after the TRIG or COMPUTE button has been depressed, a compensating correction must be entered and computed to eliminate the error.

2–10. Input Selection Matrix

a. The input selection matrix (fig. 2–9) consists of 64 windows. Along the left side of the matrix are eight buttons lettered A through H; along the bottom are eight buttons numbered 1 through 8. By depressing one letter button and one number button, the operator can select any one of 64 different inputs. As the operator selects an input, the appropriate window of the matrix lights. The use of each position of the input selection is explained in detail in table 2–1.

b. The input selection matrix is divided into seven color-coded sections for ease of identification of functions in the cannon program. The operator may use any section without regard to sequence. The seven sections are color coded as follows:

Section	*Location*	*Color*
(1) Target information	Row A	Yellow
(2) Fuze, projectile, charge overrides	Row B	Red
(3) Observer and survey information	Row C, a portion of row D, and the right half of row E	Gray

Section	Location	Color
(4) Miscellaneous information	The remainder of row D and the left half of row E	(*)
(5) Battery information	Portions of rows G and H in upper left corner	Blue
(6) No-fire area data	Left half of row F	White
(7) Registration information	Portions of rows F, G, and H in upper right corner	Green

*Color varies according to the nature of the function and for contrast with the colors of adjacent sections.

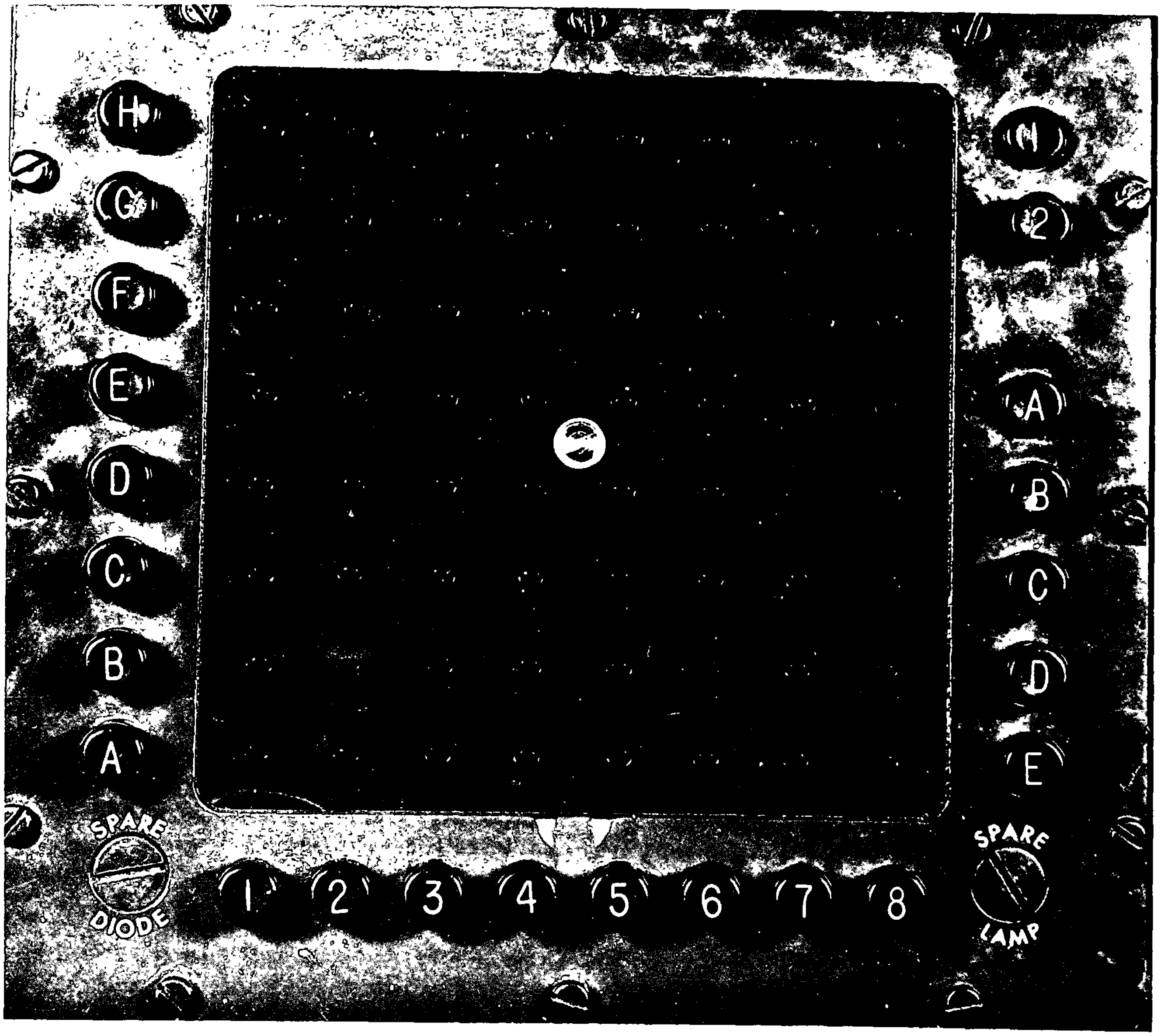


Figure 2-5. Matrix panel.

2-11. Program Tapes

a. Appendix E is a listing of the current cannon program tapes (Revision 4). These cannon program tapes are issued to each unit having a signal data reproducer AN/GSQ-64. Each cannon program tape is in two parts—a basic tape and a weapons data tape. Each set of program tapes consists of 1 basic program tape and 15 dif-

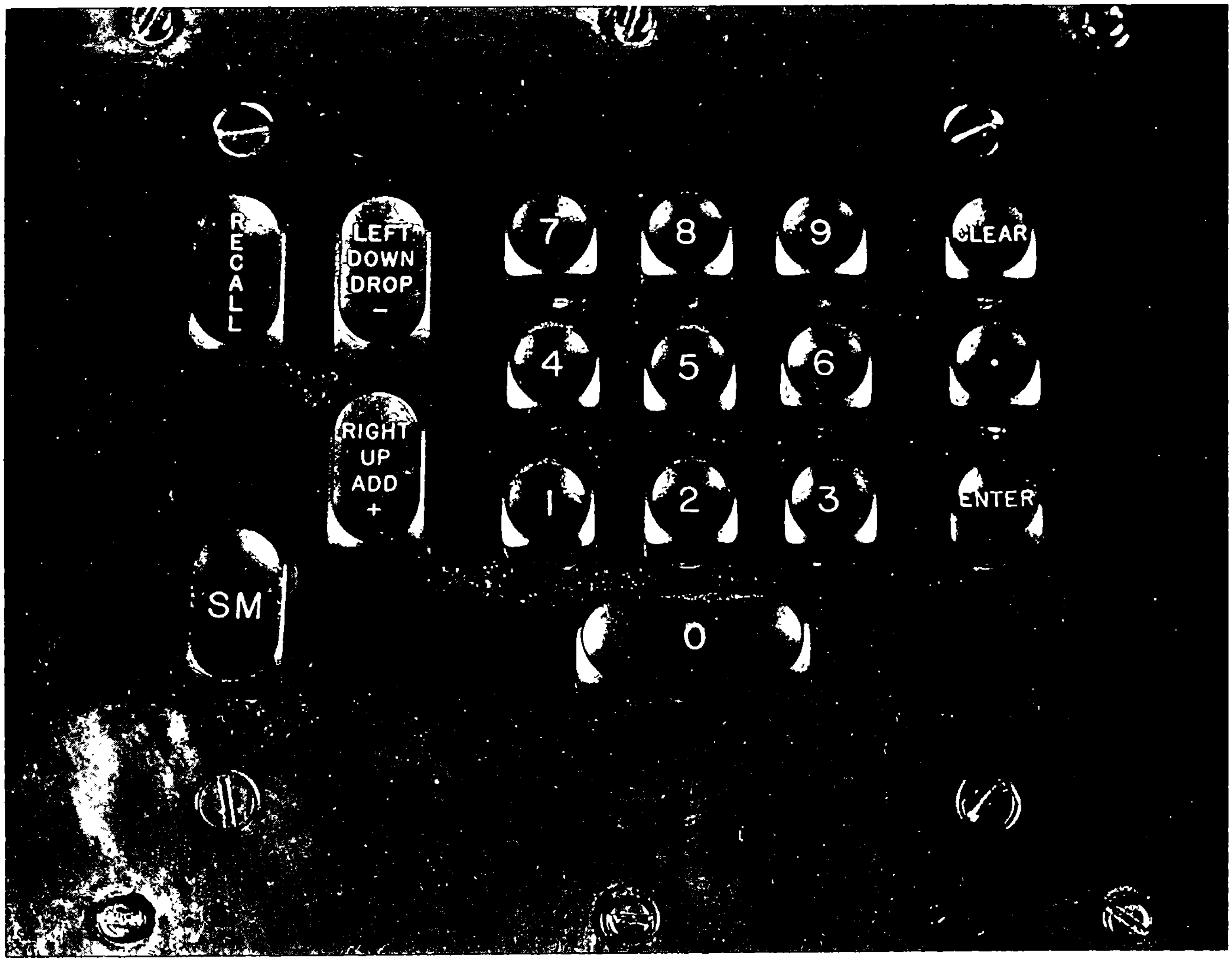
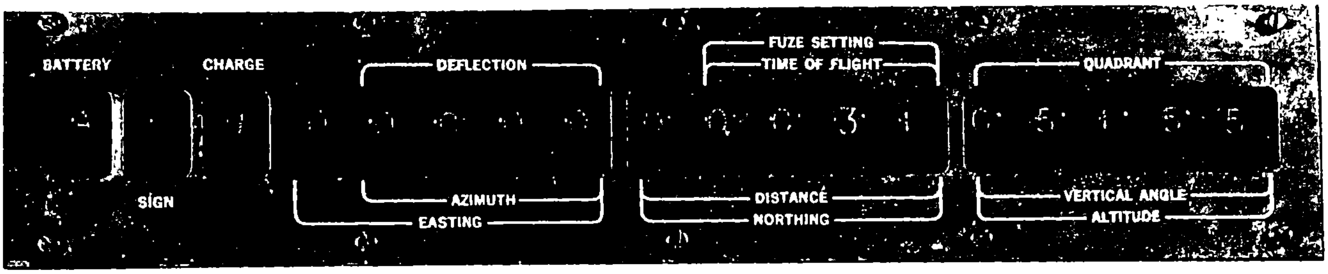


Figure 2-6. Keyboard.

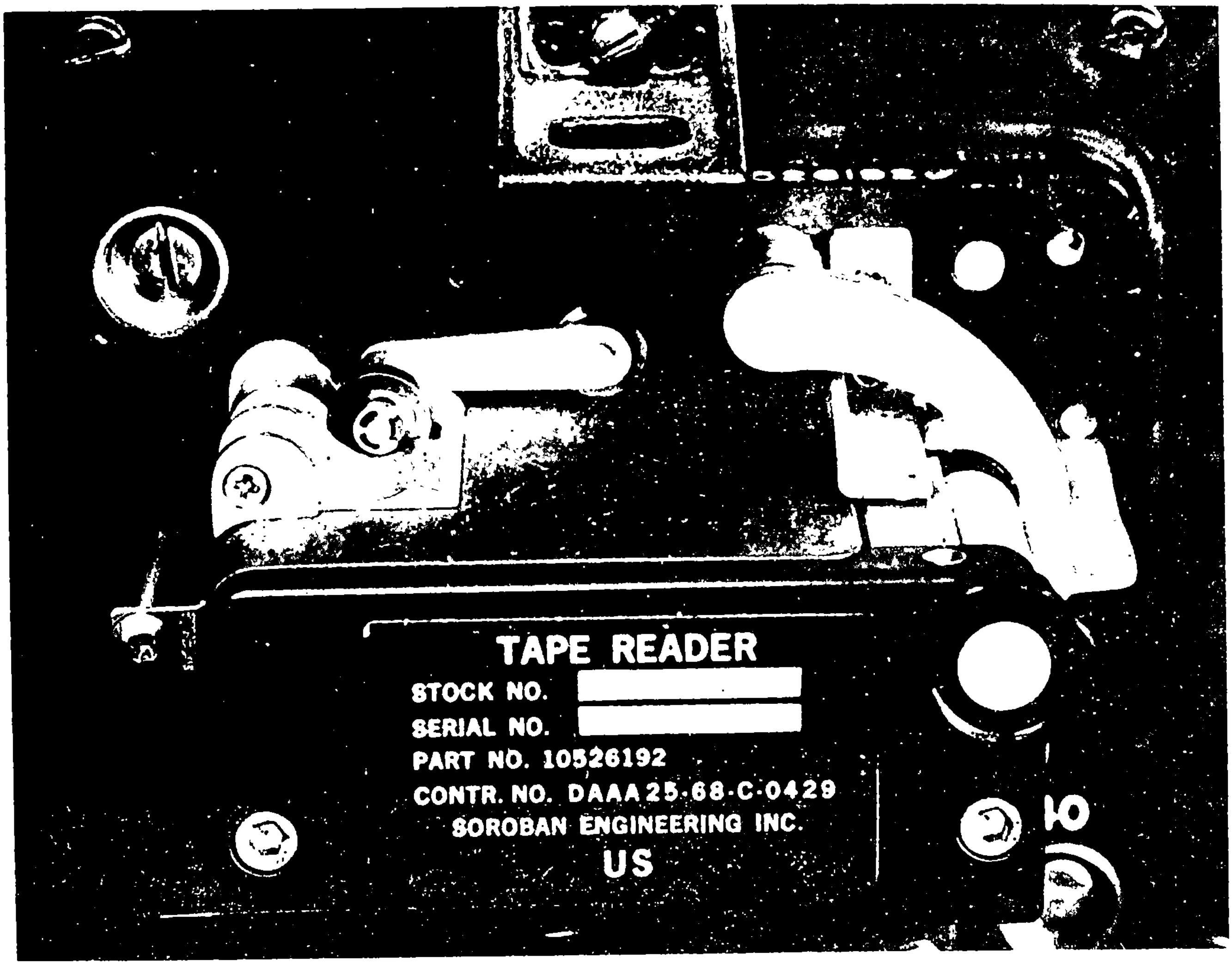
ferent weapon data tapes. The weapon data tapes include all possible combinations of data for various weapons of different calibers and series with data for two weapons on each tape. The signal data reproducer, also called the memory loading unit, is used to program the M18 computer. First, the basic program tape is loaded and then the appropriate weapons data tape for the two weapons desired is loaded. If the computer must be reprogrammed for different weapons, only the different weapons data tape will have to be loaded.

b. The basic program includes useful subroutines in addition to the solution to the ballistic problem for each weapon. These subroutines allow the operator to store the locations of up to 9 observers, 118 targets, and 39 no-fire areas and to compute traverse, intersection, zone-to-zone transformation, and orientation survey. The program will also apply registration corrections, calculate polar or rectangular replot locations, accept target locations determined by any of the three methods of observer target locating, and apply corrections during an adjust fire mision. Further, all the data for a battery fire mission can be temporarily stored in memory while another mission is conducted; then the stored mission data can be recalled and completed. Massed fires can be computed for as many as five fire units, and the trajectory maximum ordinate can be displayed for use in warning friendly aircraft. Chronograph-measured muzzle velocity can be extrapolated by using a special set of subroutines.

★*c.* The specific program entered in the computer's memory is verified during the program



★*Figure 2-7. Display panel.*



★*Figure 2-8. Mechanical tape reader.*

tests described in paragraph 2-13. The computer displays the identification of the program entered in memory by a caliber code (fig 2-10). The program security classification, program revision number, and series weapon flags are also displayed as part of the program identification. Flag cards are at appendix F.

2-12. Numbered Buttons and Battery Selector Buttons

a. The two buttons numbered 1 and 2 on the right side of the matrix panel are used to associate either the first or second caliber on the program tape with a specific battery, depending

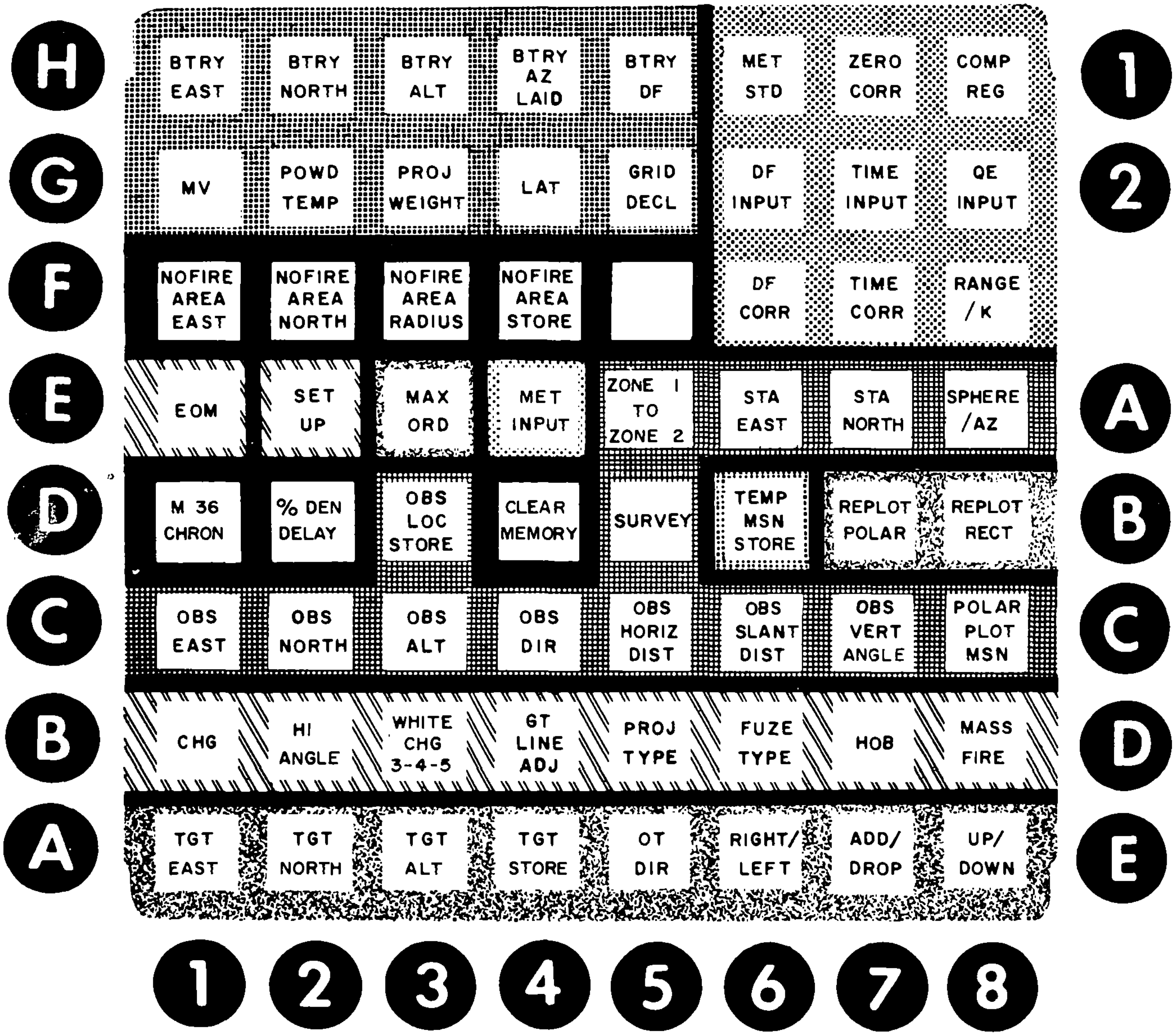


Figure 2-9. Input selection matrix.

on which numbered button and which lettered button are depressed simultaneously during set-up. For example, the first caliber on the program tape is associated with the batteries set up by depressing button number 1, and the second caliber is associated with the batteries set up by depressing button number 2.

★*b.* One of the battery selector buttons lettered A, B, C, D, and E is depressed to associate a specific battery with its portion of the program or for the computation, entry, or recall of data applicable to a specific battery. Using these buttons enables the computer to compute firing data for five separate missions.

Section IV. TESTS

2-13. General

a. The computer operator should check the computer and perform appropriate tests to insure that the computer is operating properly and that the correct program has been entered in memory. These tests are made when the computer is first set up for operation, when there is a loss of power, or when there is reason to believe that the computer is not operating properly. The desired program must be entered in the computer before the program tests are made.

b. The marginal test is built into the M18 computer and provides the operator with a means of performing a limited check of the computer's operation with various voltages. Successful completion of the marginal test insures the operator that the computer will operate properly under normal conditions.

★2-14. Program Tests

a. The procedure for testing the permanent storage of the program (program test 1) is as follows:

(1) Depress the PROG TEST button; the KEYBOARD indicator will light.

(2) Type 1 on the keyboard, and the computer will automatically make a series of tests of the program entered in the permanent part of memory. The Nixie display tubes will flicker while this test is being made. If the test is successful, the correct program identification number will appear on the display panel. A series of zeros will be displayed in the DEFLECTION window and in the three left Nixie tubes of the FUZE SETTING window. The other numbers in the display will indicate the program security classification, the program revision number, the series weapon code, and the caliber of the weapon programmed (fig 2-10). If the test is unsuccessful, the NO SOLUTION light will blink and a series of numbers other than zeros will be displayed in the DEFLECTION window.

(3) Repeat the test if the first attempt is not successful. The second or third attempt may be successful. Subsequent success after an initial test failure usually indicates the aging of parts in the computer. If several attempts are frequently required for successful completion of the test, maintenance checks should be performed to determine the specific cause.

b. The procedure for testing the working storage (Program Test 2) is as follows:

(1) Depress the PROG TEST button; the KEYBOARD indicator will light.

(2) Type 2 on the keyboard. The computer will automatically test the working storage portion of the memory. During the test, the rightmost Nixie tubes in the QUADRANT window of the display panel will rapidly display the channel numbers being checked and, if the test is successful, will finally display the number 136. If the test is not successful, the PARITY indicator will flicker and the channel number in which the error occurred will be displayed. The channel numbers allocated to working storage are shown in figure 2-14, map of memory working storage.

(3) If the test is unsuccessful, the incorrect channel must be cleared by using the procedure described in table 2-1 for matrix position D-4 (CLEAR MEMORY). After the channel has been cleared and the correct data for that channel have been entered, repeat the test.

c. One method of testing proper computer operation is to cause the computer to solve a sample problem for which the answer is known. This test should be performed only during lulls in firing or during maintenance periods.

2-15. Marginal Test

★*a.* The marginal test procedure is as follows:

(1) When the POWER READY indicator lights, turn the MARGINAL TEST switch to the 1 position.

(2) Depress the PROG TEST button and the 1 key on the keyboard. This action will initiate the program test described in paragraph 2-14. Blinking of the PARITY or ERROR indicator will indicate that computer has malfunctioned under the marginal conditions induced by placing the switch in the 1 position and that the computer may malfunction under normal voltages.

(3) If neither of the indicators blinks, turn the switch to test position 2 and depress the PROG TEST button and the 1 key. Blinking of the PARITY or ERROR indicator will indicate that the computer has malfunctioned under the marginal conditions induced by placing the switch in the 2 position.

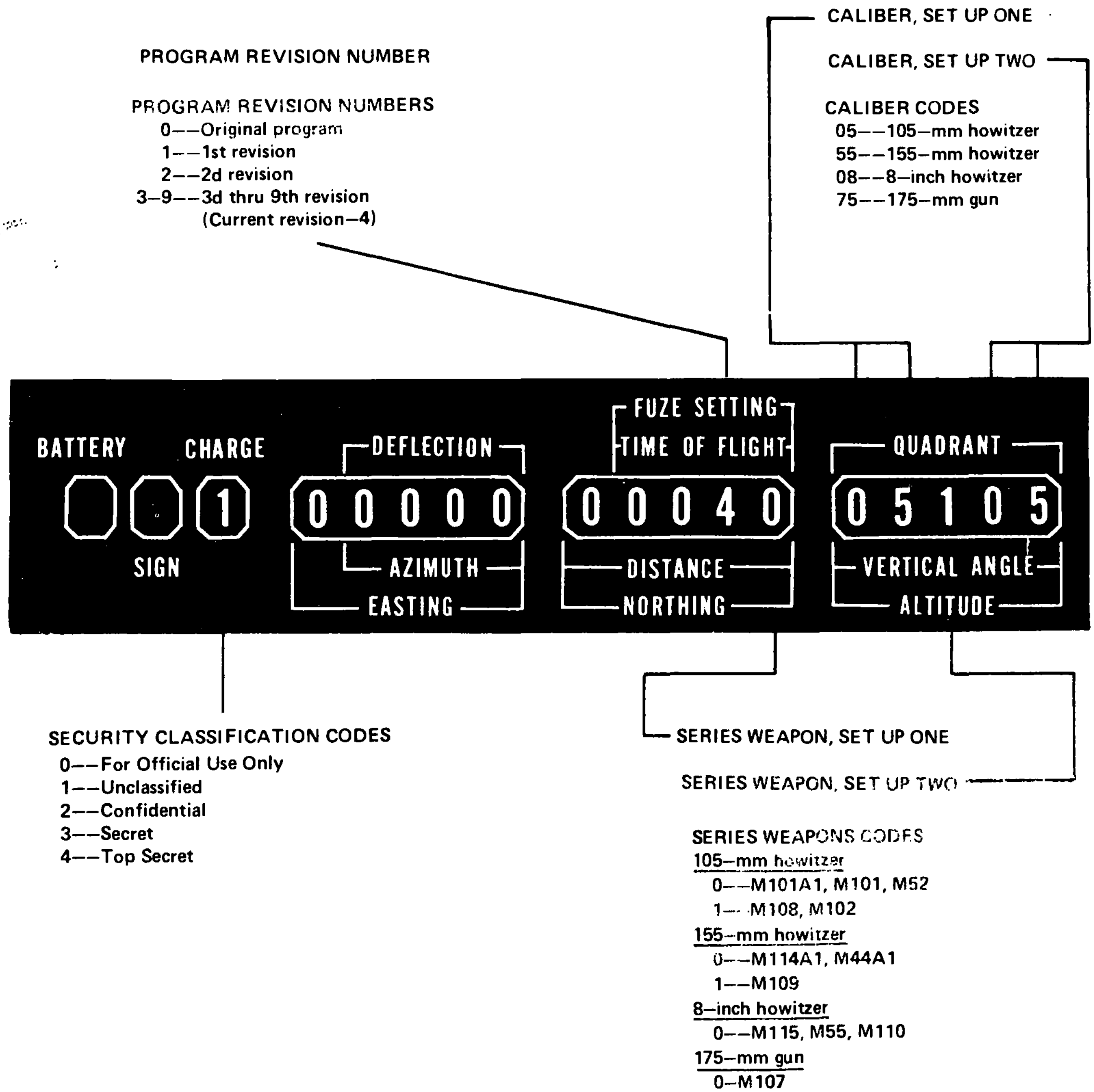
(4) Repeat the procedures in (2) above with the MARGINAL TEST switch in test positions 3, 4, and 5. If neither the PARITY nor the ERROR indicator blinks when the switch is placed in each of the five test positions, the computer is functioning properly. When the test indicates a malfunction, the computer should be checked by maintenance personnel as soon as possible.

b. Placing the MARGINAL TEST switch in each of the five test positions causes the POWER READY indicator light to blink; however, this does not indicate a malfunction. In normal operation the MARGINAL TEST switch should be in the OFF position.

c. The PARITY indicator may blink when the MARGINAL TEST switch is rotated from one position to another. If it does, depress the RESET button. The indicator should stop blinking. If blinking does not stop, turn off the computer and then turn it on again.

2–16. Display Test

a. The procedure for testing the Nixie display tubes is as follows:



★*Figure 2–10. Successful program test 1 display.*

(1) Depress the PROG TEST button; the KEYBOARD indicator will light.

(2) Type 3 on the keyboard. The computer will automatically test the Nixie tube by successively lighting each filament starting with 0 and ending with the decimal point. In addition, the + and − filaments in the SIGN window will be lighted in turn.

b. The operator should observe the display panel and insure that each filament lights properly. Defective tubes should be replaced at once.

Section V. COMPUTER INPUTS

2-17. General

a. The input selection matrix and the keyboard are the principal means used to insert data into the computer. The mechanical paper tape reader is used to insert meteorological information received in tape form. The matrix, the keyboard, and the control buttons enable the operator to initiate a problem solution by issuing instructions to the computer in standard artillery terminology or in simple codes of one- or two-digit numbers.

b. Input elements should be based on the most accurate information available. If some of the elements are not known, the information that is known should be entered and the unknown data should be either left at standard or entered on an experience factor basis.

c. The input elements that affect the ballistic trajectory solution are discussed below:

(1) *Battery information.* The battery easting, battery northing, and battery altitude are required inputs.

(2) *Target information.* The target easting, target northing, and target altitude are required inputs.

(3) *Azimuth laid and deflection.* The azimuth on which the battery is laid and the deflection at which the aiming posts are placed (referred deflection) must be entered.

(4) *Latitude.* The latitude of the battery may be obtained from the marginal data on a map of the area in which the unit is operating. This latitude should be the latitude of the center of the battalion area and will apply for all batteries.

(5) *Grid declination.* The grid declination is obtained from the marginal data on a map of the area and applies to all batteries. It is the angular difference between true north and grid north.

(6) *Powder temperature.* The powder temperature is obtained from the firing battery and is measured with a powder thermometer. Since only one powder temperature for a battery can be entered at a time, the temperature should be obtained by actually measuring the temperature of the lot of propellant to be fired.

(7) *Projectile weight.* The projectile weight input is the absolute weight of the projectile in pounds. The projectile weight may be stenciled on the shell or be coded in squares on the shell. Projectile weights coded in squares must be converted to pounds (appendix C). The projectile weight for each different type of shell is obtained from the battery executive officer's report, i.e., shell HE, shell WP. Whenever a different lot of projectiles is to be fired, new data should be entered.

(8) *Meteorological data.* Meteorological data prepared specifically for computer use are furnished periodically by a met station. The methods used in preparing a computer met message are described in FM 6-15. Meteorological data may be in the form of a computer met message or a punched paper tape. Met data in the form of a computer met message are manually entered in the computer through the keyboard. Data in tape form are entered through the mechanical tape reader. The correct procedures for preparing met message tapes are described in appendix B.

(9) *Registration corrections.* When registration corrections are computed and applied with the M18 computer, a current met message as well as all other ballistic parameters must be entered in the computer before matrix function H-8 (COMP REG) is used. If this is done, the change in weather will be correctly applied when a new met message is entered. If either standard met data or old invalid met data are in the computer when registration corrections are computed, the registration corrections will include the errors in met as well as any other incorrect parameters previously entered in the computer. Subsequently, when current valid met data and other known conditions are entered in the com-

puter, matrix position H-7 (ZERO CORR) should be used to delete corrections; otherwise, inaccurate firing data will result.

(10) *Muzzle velocity.* The muzzle velocity (MV) may be measured with the M36 chronograph or determined from fall-of-shot calibration data or precision registration data. These three methods for determining muzzle velocity are as follows:

★(*a*) Muzzle velocity can be measured with the M36 chronograph during any type of fire mission. The muzzle velocity measured by the chronograph is a measure of the shooting strength of the weapon, ammunition, and charge combination. It is recommended that a minimum of six rounds preceded by two conditioning rounds be fired with each charge and lot combination being measured. The muzzle velocity is entered for each charge if it is known; otherwise, the computer automatically uses a standard value. This method is the preferred method for determining muzzle velocity. See paragraph 3-12 for further techniques.

(*b*) When current met data and other known elements that affect the trajectory have been entered in the computer, the muzzle velocity can be determined from registration. A trial and error procedure is used to adjust the muzzle velocity with matrix function G-1 (MV) until the adjusted QE is displayed. A general rule to follow is to change the muzzle velocity 3 meters per second for each 5 mils of QE at midrange. Once a bracket has been established, continue to split the bracket until the adjusted QE is displayed. Since more than one muzzle velocity may produce the same QE, move 0.2 meter per second in each direction until a high and a low muzzle velocity have been determined. Use the mean, or average, value for the final muzzle velocity. This method of determining muzzle velocity is fast and accurate and does not require the use of firing tables. This method may be used only when the muzzle velocity is the single unknown factor. Valid meteorological data, accurate powder temperature, the projectile weight, the location of the registering piece, the location of the target, the latitude, and the grid declination must be entered. The accuracy of the muzzle velocity obtained will depend on the accuracy of these inputs.

(*c*) The fall-of-shot calibration data may be used to determine the muzzle velocity. This is actually a velocity error (VE) converted to muzzle velocity. It absorbs the errors at the time of firing and is valid only for the projectile lot and propellant lot used in the calibration. The computed VE is converted to MV by algebraically adding the VE to the standard muzzle velocity. The VE's derived from a registration with a concurrent met may be similarly used; however, this is the least preferable method.

★2-18. Meteorological Message Input Procedures

a. Entry of the most recent meteorological data is vital to the computation of accurate firing data for surprise fires. The special computer met message (METCM), used by the M18, reports weather conditions which actually exist in the various layers of atmosphere through which the trajectory passes. The computer message is different from the met message used in manual computations in which the weather conditions existing in one layer, or zone, are weighted against conditions existing in lower layers and reported as percentages of standard. The M18 *cannot* use the weighted met message.

b. In the cannon program, the met input is stored in channels 134 and 136 of the working storage. A maximum of 26 lines of met data can be entered. The standard met data are placed in memory when the program is first loaded and are used when the met is set to standard by using matrix function H-6 (MET STD). If fewer than 26 lines of met data are subsequently entered, the remaining lines of standard met data previously entered will still be in memory.

c. The manual entry of met data is accomplished as follows:

(1) Depress matrix buttons E-4 (MET INPUT). Then depress the SM key to prepare the computer for keyboard input.

(2) On the keyboard, type 0 and depress the ENTER key; the number 88 will be displayed.

(3) On the keyboard, type the identification line (12 digits) of the met message starting with the date-time group. Then depress the ENTER key; the number 00 will be displayed.

(4) On the keyboard, type the 00 line (16 digits) of the met message, starting with 00. Then depress the ENTER key; the number 01 will be displayed.

(5) Enter each of the remaining lines of the met message in the same manner. When the last

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line has been entered, terminate the input mode by typing 9 and depressing the ENTER key.

d. If a mistake made in any line entry is discovered after the input mode has been terminated, a correction can be made as follows:

(1) Depress the SM key and type 2 on the keyboard.

(2) On the keyboard, type the number of the line to be reentered. (The line number will be displayed.)

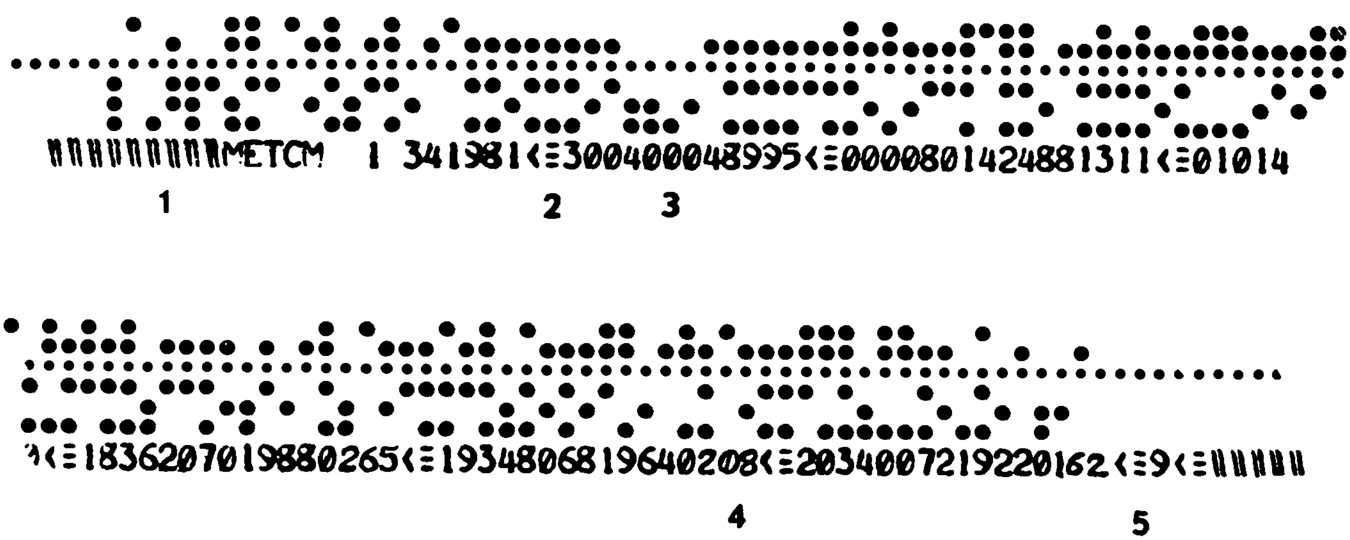
(3) On the keyboard, type the correct 16-digit line.

e. Entering a met message punched on paper tape is the fastest method of entering met data. Meteorological message tapes (fig 2–11) are usually cut by radio teletypewriter equipment, such as the teletypewriter reperforator-transmitter TT–76/GGC, which is a component of radio sets AN/GRC–46, AN/GRC–122, and AN/GRC–142. If the tape is cut by a radio teletypewriter, there will be a printout of the met data lengthwise along the bottom of the tape. The procedure for placing the met message tape in the mechanical tape reader is as follows:

(1) A slightly off-center line of small sprocket holes runs the length of the tape. Opposite each sprocket hole, there may be as many as three punched holes on the wide side of the tape and as many as two punched holes on the narrow side of the tape. Determine the front of the tape by placing the wide side toward the computer with the printing up. Open the armature clamp on the mechanical tape reader and place the tape under the clamp with the wide side—three holes—toward the computer. Insure that the message portion of the tape is to the left of the read head (fig 2–12).

(2) Engage the tape sprocket holes with the reader sprocket and close the armature clamp (fig 2–13). Turn the sprocket knob a few times to insure that the tape is properly engaged. If the tape does not move freely, open the clamp and insure that the sprocket holes are engaged by the sprocket teeth. Reclose the clamp and turn the sprocket knob again to insure proper threading.

(3) Depress matrix buttons E4 (MET INPUT). Then depress the SM key to prepare the computer for keyboard input.



1. **Tape Advance Symbol at Front of Tape.**
2. **Line Feed Carriage Return Symbol.**
3. **Identification line.**
4. **Last line of meteorological message.**
5. **Line Feed Carriage Return, Stop Code (9) symbols.**

Figure 2–11. Meteorological message tape.

(4) On the keyboard, type 3 and depress the ENTER key. The reader will automatically start reading the tape. Insure that the tape does not become tangled as it moves through the reader. The reader will stop automatically at the end of the tape, and the input mode will be terminated.

2-19. Functions Demanding a Signal Input

a. Several matrix functions require that a plus or minus sign precede the numerical entry. The RIGHT, UP, ADD, + and LEFT, DOWN, DROP, − keys on the keyboard are used to input these signs.

b. Each of the following matrix functions require that a sign precede the numerical entry:

(1) A-6 (RIGHT LEFT).

(2) A-7 (ADD/DROP).

(3) A-8 (UP/DOWN).

(4) C-7 (OBS VERT ANGLE).

(5) E-5 (ZONE 1 TO ZONE 2).

(6) F-6 (DF CORR).

(7) F-7 (TIME CORR).

(8) F-8 (RANGE/K).

(9) G-2 (POWD TEMP).

(10) G-4 (LAT).

(11) G-5 (GRID DECL).

2-20. Enabling Procedure

a. The enabling procedure is designed to act as a safeguard against inadvertent entry of an error. The enabling procedure is required in the use of certain matrix functions and is used for functions that override the normal program parameters, e.g., function H-6 (MET STD). The computer ordinarily computes the trajectory with current data; therefore, if standard met is to be used, matrix buttons H and 6 are depressed. Then the SM key is depressed, and the KEYBOARD indicator will light. Then, a keyboard entry of 0 is made to indicate that the computer is to use

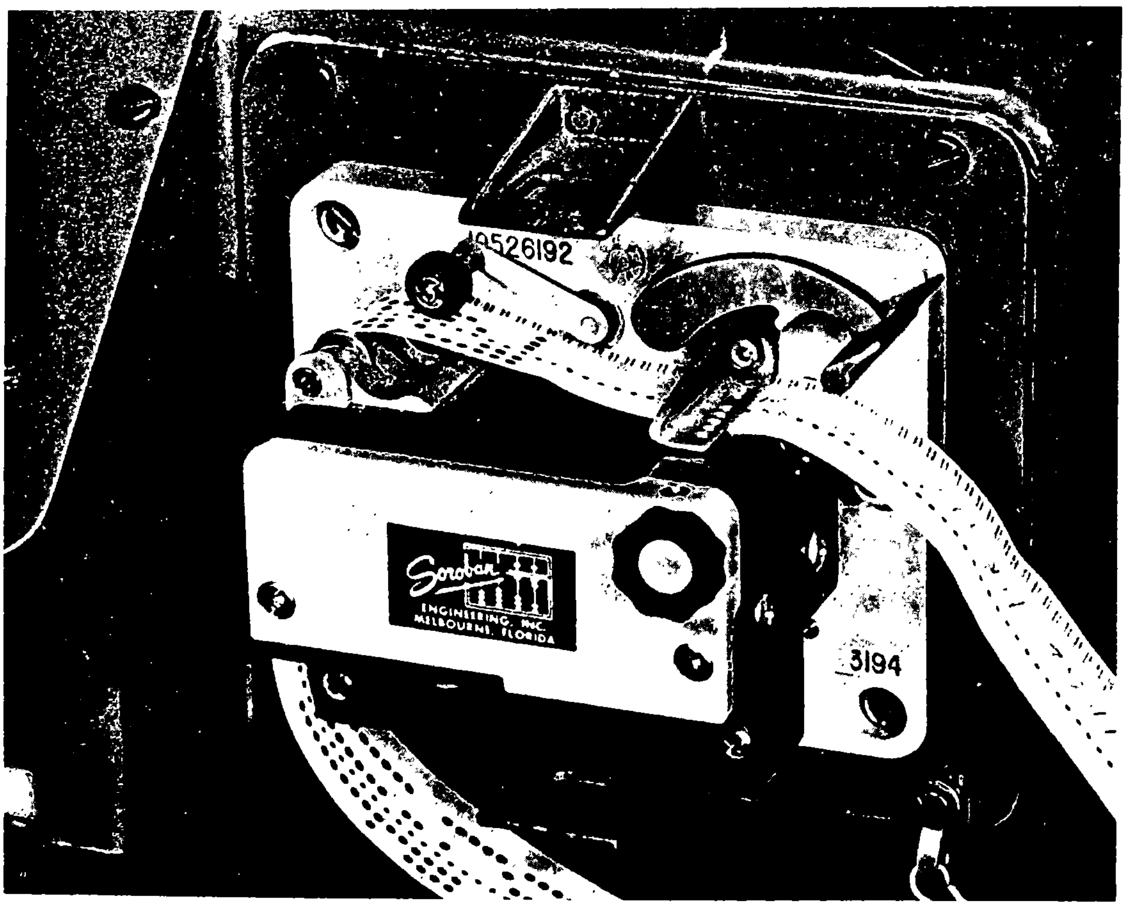


Figure 2-12. Meteorological message tape in reader.

standard met, or 9 is typed on the keyboard to indicate that the computer is to disregard the proposed entry and terminate the input mode.

b. Each of the following matrix functions requires an enabling procedure.

(1) B-2 (HI ANGLE).

(2) B-3 (WHITE CHG 3, 4, 5).

(3) B-4 (GT LINE ADJ).

(4) D-1 (M36 CHRON).

(5) D-6 (TEMP MSN STORE).

(6) E-1 (EOM).

(7) H-6 (MET STD).

(8) H-7 (ZERO CORR).

★2-21. Functions Reset to Minus Zero

★The computer automatically resets most functions to zeros, preceded by a minus sign. This form is referred to in this manual as minus zero. When a function has been reset to minus zero, the computer will demand an entry for that function in subsequent computations. This function is a safety feature to avoid errors caused by the failure of the operator to enter complete data for a problem solution. For example, function E-1 (EOM) resets all target data to minus zero; then, if the operator enters the target easting for a subsequent mission but forgets to enter the target northing, the computer will not use the minus zero northing. Instead, the NO SOLUTION indicator will blink and the 6 error flag will be displayed.

2-22. Detailed Matrix Functions

a. Table 2-1 presents detailed instructions on the use of each of the input selection matrix function for the entry or recall of data. The information presented in table 2-1 is as follows:

(1) The "input function" column identifies each function by the abbreviated designation which appears on the input selection matrix for the cannon program.

(2) The "matrix location" column indicates the location of each function on the input selection matrix by the letter button (A through H) and the number button (1 through 8) used to

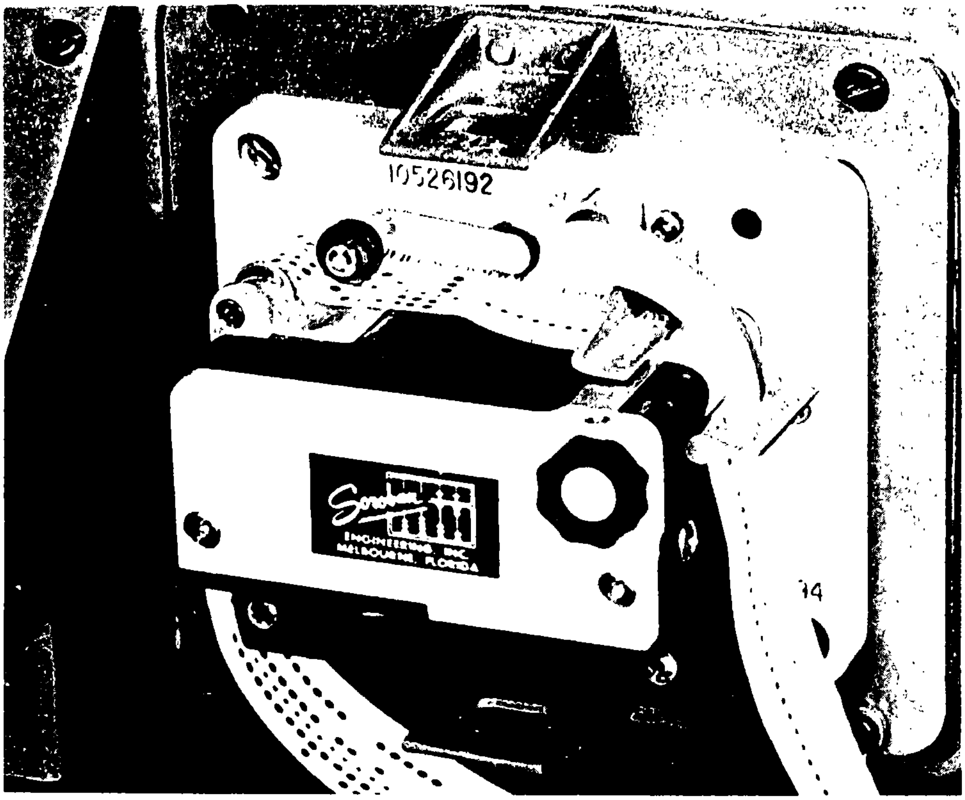


Figure 2-13. Tape in reader, armature clamp closed.

select the function. The input functions are listed in table 2-1 in alphabetical and numerical order from A-1 to H-8.

(3) The "battery" column indicates whether a function is battery-associated data. If the word "specific" appears in this column, the input data must be entered with a specific battery button depressed to associate the data with that battery. If the word "any" appears in this column, it does not matter which battery button is depressed. In all cases, a battery button must be depressed to start the computations; otherwise, the NO SOLUTION indicator will blink.

(4) The "entry procedure" column presents detailed instructions for entering data for a specific function or the steps in problem solution presented by a particular function. The instruction to "enter" certain data means to type the data on the keyboard and then to depress the ENTER key when data are displayed on the display panel. Some functions, such as D-5 (SURVEY), require the entry of more than one element of information in a specific sequence. Unless a specific entry sequence is indicated, information may be entered in any convenient sequence.

(5) The "recall procedure" column presents detailed instructions for recalling information stored in memory. Each input function that is not recallable is indicated by the abbreviation "NA" or by explanation of the procedure to be used instead of using the RECALL key.

(6) The "remarks" column contains comments about the function and cautions on its use.

b. A graphic illustration of the location in memory of input data is shown in figure 2-14. If function D-4 (CLEAR MEMORY) has been used and the data are to be reentered, the operator should refer to figure 2-14 to determine specifically which data to re-enter.

CHANNEL NUMBER	DATA STORED IN MEMORY LOCATIONS				
70	BTRY C	SPECIFIC BATTERY/MISSION DATA		SURVEY	GRID DECL G, 5
		1. SET UP PARAMETERS E, 2			
72	BTRY A	2. BATTERY INPUT DATA: G, 1–5, H, 1–5		INPUT INFORMATION	MASS FIRE B, 8
74	BTRY B	3. TARGET INPUT DATA: A, 1–4		AS DESIGNATED FOR	
110	BTRY D	4. OT DIR A, 5		D, 5	
		5. OVERRIDES B, 1–7			
130	BTRY E	6. FIRING DATA, COMPUTE OR TRIG			
76	LATITUDE G, 4	TARGET A, 1–3	REGISTRATION CORRECTIONS G, 6–8, B, 1, 5 and 6	INTERIM STORAGE	
112	TARGET LIST (1 - 118) A, 4			TEMP MSN DATA - D, 6	BTRY C
114					BTRY A
116	NO FIRE AREA LIST (1–39) F, 4				BTRY B
132	INTERIM STORAGE		SURVEY INPUT AS DESIGNATED FOR D, 5		BTRY D
134	MET MESSAGE E, 4	OBSERVER LIST (1 9) D, 3			BTRY E
136	METEOROLOGICAL MESSAGE E, 4				

Figure 2-14. Map of memory working storage.

Table 2-1. Detailed Matrix Functions

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
TGT EAST	A–1	Specific	1. Depress matrix buttons A–1. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the target easting to the nearest meter. 4. Depress the ENTER key.	1. Depress matrix buttons A–1. (Matrix window will light.) 2. Depress the RECALL key. (Target easting will be displayed.)	1. Used to enter easting coordinates of target. 2. Five-digit coordinates must be used. If not, the NO SOLUTION indicator will flicker and the display will remain. 3. Reset to minus zero by EOM.
TGT NORTH	A–2	Specific	1. Depress matrix huttons A–2. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the target northing to the nearest meter. 4. Depress the ENTER key.	1. Depress matrix buttons A–2. (Matrix window will light.) 2. Depress the RECALL key. (Target northing will be displayed.)	1. Used to enter northing coordinates of target. 2. Five-digit coordinates must be used. If not, the NO SOLUTION indicator will flicker and the display will remain. 3. Reset to minus zero by EOM.
TGT ALT	A–3	Specific	1. Depress matrix buttons A–3. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the altitude to the nearest meter. 4. Depress the ENTER key.	1. Depress matrix buttons A–3. (Matrix window will light.) 2. Depress the RECALL key. (Altitude will be displayed.)	1. Used to enter altitude of target above sea level. 2. Reset to minus zero hy EOM. 3. If no TGT ALT is input, computer will use the battery altitude for the target altitude in computations.
TGT STORE	A–4	Specific	1. Enter target coordinates by using matrix functions A–1 (TGT EAST), A–2 (TGT NORTH), and A–3 (TGT ALT). 2. Depress matrix buttons A–4. (Matrix window will light.) 3. Depress the SM key. (KEYBOARD indicator will light.) 4. On the keyhoard, type the assigned target file number (1–118). 5. Depress the ENTER key. (The COMPUTE indicator will light momentarily and the target coordinates and altitude will be displayed.)	1. Depress matrix huttons A–4. (Matrix window will light.) 2. Depress the RECALL key. (KEYBOARD indicator will light.) 3. On the keyboard, type the file number (1–118) of the target to be recalled. 4. Depress the ENTER key. Target coordinates and altitude will be displayed.	1. This function will be used to place a target on the target list in the computer's memory. 2. The NO SOLUTION indicator will flicker if a number larger than 118 is entered. 3. Since 0 is reserved for recall of a battery-associated target, if cannot be used as a target number.
OT DIR	A–5	Specific	1. Depress matrix buttons A–5. (Matrix window will light.)	1. Depress matrix buttons A–5. (Matrix window will light.)	1. Used to enter the azimuth from the observer to the target.

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
OT DIR	A-5 (Cont)		2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (Observer-target azimuth will be displayed.)	2. Reset to minus zero by EOM.
			3. On the keyboard, type the observe-target azimuth to the nearest mil (0 to 6400 mils).		3. This entry will not be used if GT LINE ADJ (B-4) or POLAR PLOT MSN (C-8) is used.
			4. Depress the ENTER key.		
RIGHT/LEFT	A-6	Specific	1. Depress matrix buttons A-6. (Matrix window will light.)	1. Depress matrix buttons A-6. (Matrix window will light.)	1. Target coordinate values will be modified as a result of the shift.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. Correction will be displayed. (A left correction has a minus sign; a right correction has a plus sign.)	2. Automatically reset to minus zero during computation.
			3. On the keyboard, type LEFT or RIGHT and the correction to the nearest meter. (LEFT will cause a minus sign (-) to be displayed; RIGHT will cause a plus sign (+) to be displayed.)		
ADD/DROP	A-7	Specific	1. Depress matrix buttons A-7. (Matrix window will light.)	1. Depress matrix buttons A-7. (Matrix window will light.)	1. Target coordinate values will be modified as a result of the shift.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (Correction will be displayed. A plus sign will be displayed for an ADD correction; a minus sign, for a DROP correction.)	2. Automatically reset to minus zero during computation.
			3. On the keyboard, type ADD or DROP and the correction to the nearest meter. (ADD will cause a plus sign to be displayed; DROP will cause a minus sign to be displayed.)		
			4. Depress the ENTER key.		
UP/DOWN	A-8	Specific	1. Depress matrix buttons A-8. (Matrix window will light.)	1. Depress matrix buttons A-8. (Matrix window will light.)	1. Target altitude will be modified as a result of the shift.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (Correction will be displayed. A plus sign will be displayed for an UP correction; a minus sign, for a DOWN correction.)	2. Automatically reset to minus zero during computation.
			3. On the keyboard, type UP or DOWN and the correction to the nearest meter. (UP will cause a plus sign to be displayed; DOWN will cause a minus sign to be displayed.)		

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
UP/DOWN	A-8 (Cont)		4. Depress the ENTER key.		
CHG	B-1	Specific	1. See remarks before using function.	1. Depress matrix buttons B-1. (Matrix window will light.)	1. This is an override function. The computer will normally select its own charge unless this override is directed.
			2. Depress matrix buttons B-1. (Matrix window will light.)	2. Depress the RECALL key. (Charge will be displayed.)	2. Selection of charge may be changed at any time during the mission by following the entry procedure.
			3. Depress the SM key. (KEYBOARD indicator will light.)		3. This function *must* be used to enter a specific charge before function H-8 (COMP REG) is used or when used in the chronograph extrapolation routine.
			4. On the keyboard, type the charge desired (1 to 7).		4. Computer will again select its own charge after— *a.* EOM (E-1) has been selected. *b.* A charge of zero has been entered.
			5. Depress the ENTER key.		5. See appendix C to determine permissible charges.
HI ANGLE	B-2	Specific	1. Depress matrix buttons B-2. (Matrix window will light.)	1. Depress matrix buttons B-2. (Matrix window will light.)	1. Unless this input function is selected, the computer will give the solution for low-angle fire.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (If HI ANGLE has been selected for this mission, a 0 will be displayed. If HI ANGLE has not been selected for this mission, a 9 will be displayed.	2. After selection of this function for a mission, firing data will be computed for high-angle fire until this function is dismissed. To dismiss this function and return to low-angle fire, the following procedure is used: *a.* Perform steps 1 and 2, entry procedure. *b.* Depress 9 on the keyboard. (KEYBOARD indicator will go out.)
			3. On the keyboard, type 0 to cause the computer to solve the mission for high-angle fire. (KEYBOARD indicator will go out.)		3. This function will be dismissed automatically by E-1 (EOM).
WHITE CHG 3, 4, 5	B-3	Specific	1. Depress matrix buttons B-3. (Matrix window will light.)	1. Depress matrix buttons B-3. (Matrix window will light.)	1. This override is used to have the computer compute the mission for white bag charges 3, 4, 5 and the computer normally selects green bag for charges 1 to 5 and white bag for charges 6 and 7. Enabling this override function causes the computer to select the parameters for white bag propellant charges 3, 4, and 5 for the 155-mm howitzer and for charge

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
WHITE CHG 3, 4, 5	B–3 (Cont)				5 with the 8-inch howitzer, both in the cannon ballistic compute routine and in the chronograph extrapolation program.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (If WHITE CHG 3, 4, 5 (B–3) have been selected for this mission, a 0 will be displayed; if not, a 9 will be displayed.)	2. This function is dismissed by E–1 (EOM).
			3. On the keyboard, type 0 to cause the computer to solve the mission by using white bag charges 3, 4, or 5 data.		3. If this function has been selected and the SM key has been depressed, the function can be dismissed by depressing 9 on the keyboard.
GT LINE ADJ	B–4	Specific	1. Depress matrix buttons B–4. (Matrix window will light.)	1. Depress matrix buttons B–4. (Matrix window will light.)	1. This function is used to effect corrections with respect to the gun-target line instead of the observer target line.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (If GT LINE ADJUST (B–4) has been selected for the mission, a 0 will be displayed; if GT LINE ADJUST has not been selected for this mission, a 9 will be displayed.)	2. This function is dismissed by E–1 (EOM).
			3. On the keyboard, type 0 to cause the computer to use the gun-target azimuth in adjustment.		3. Azimuth of gun-target line can be recalled by following the recall procedures outlined for OT DIR (A–5).
					4. If this function has been selected and the SM key has been depressed, the function can be dismissed by depressing 9 on the keyboard.
PROJ TYPE	B–5	Specific	1. Depress matrix buttons B–5. (Matrix window will light.)	1. Depress matrix buttons B–5. (Matrix window will light.)	★1. The computer normally selects shell HE. In the chronograph program, the appropriate projectile flag must be entered.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key, shell model flag will be displayed.	2. This is an override function and is dismissed by E–1 (EOM) or by the selection of flag 1.
			★3. On the keyboard, type the appropriate flag for the desired projectile type. (See app C for projectile flags in the cannon program.)		3. This override can be changed at any time during the mission.
			4. Depress the ENTER key.		4. See appendix C for shell-fuze combinations.

FUZE TYPE	B–6	Specific	1. Depress matrix buttons B–6. (Matrix window will light.)	1. Depress matrix buttons B–6. (Matrix window will light.)	1. For fuze time or fuze VT, program will compute a 20-meter height of burst except for VT high-angle fire.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (Flag will be displayed.)	2. The computer normally selects fuze quick and displays time on flight. If fuze time or fuze VT is used, the fuze setting will be displayed instead of time of flight.
			3. On the keyboard, type the appropriate flag for the desired fuze type. (See appendix C for fuze flags.)		3. This is an override function and is dismissed by E–1 (EOM) or by the selection of flag 1.
			4. Depress the ENTER key.		4. The program will subtract 2 seconds from the fuze setting for a zero height of burst (fuze time) to determine the fuze setting for base-ejection smoke rounds.
					★5. When fuze VT, M513 or M514 is used, 0.5 pound must be added to the projectile weight to compensate for the added weight of the fuze over that of the standard VT fuze. See appendix C for other fuze weight compensations.
					6. This override can be changed at any time during the mission.
					7. See appendix C for shell-fuze combinations.
HOB	B–7	Specific	1. Depress matrix buttons B–7. (Matrix window will light.)	1. Depress matrix buttons B–7. (Matrix window will light.)	1. This function is used only with shell types 4 and 5 for the 8-inch howitzer and shell type 5 for the 155-mm howitzer.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (Height of burst selected will be displayed.)	2. This function is reset to minus zero by E–1 (EOM).
			3. On the keyboard, type the actual height of burst above the target.		
			4. Depress the ENTER key.		
MASS FIRE	B–8	Specific	1. Insure that the button for the battery with which the target is associated is depressed.	1. Depress matrix buttons B–8. (Matrix window will light.)	1. This function transfers the target associated with the battery button depressed in step 1 to the batteries selected in step 4.
			2. Depress matrix buttons B–8. (Matrix window will light.)	2. Depress the RECALL key. (Flags of batteries selected will be displayed.)	2. The appropriate battery button must be depressed to cause the computer to compute the firing data for each battery selected, and specific overrides for each battery selected must be entered sepa-

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
MASS FIRE	B–8 (Cont)		3. Depress the SM key. (KEYBOARD indicator will light.) 4. On the keyboard, type all of the batteries to be massed by using flags shown below: *Flag* — *Battery* 1 — A 2 — B 3 — C 4 — D 5 — E 5. Depress the ENTER key.		rately. The COMPUTE button must then be depressed.
OBS EAST	C–1	Any	1. Depress matrix buttons C–1. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the observer easting to the nearest meter. 4. Depress the ENTER key.	1. Depress matrix buttons C–1. (Matrix window will light.) 2. Depress the RECALL key. (Observer easting will be displayed.)	1. This function is used to input the observer easting for use in certain survey routines or in polar plot missions. 2. Five-digit coordinates must be used. If not, the NO SOLUTION indicator will flicker and the display will remain. 3. See SURVEY (D–5).
OBS NORTH	C–2	Any	1. Depress matrix buttons C–2. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the observer northing to the nearest meter. 4. Depress the ENTER key.	1. Depress matrix buttons C–2. (Matrix window will light.) 2. Depress the RECALL key. (Observer northing will be displayed.)	1. Used to input the observer northing for use in certain survey routines or a polar plot mission. 2. Five-digit coordinates must be used. If not, the NO SOLUTION indicator will flicker and the display will remain. 3. See SURVEY (D–5).
OBS ALT	C–3	Any	1. Depress matrix buttons C–3. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the observer altitude to the nearest	1. Depress matrix buttons C–3. (Matrix window will light.) 2. Depress the RECALL key. (Altitude will be displayed.)	1. Used to input the observer altitude for use in the survey routine or a polar plot mission. 2. See SURVEY (D–5). 3. If the observer is below sea level, add a sufficient amount to true altitude to

meter.

4. Depress the ENTER key.

change the value from minus (−) to plus (+). An equal amount must be added to the TGT ALT (A-3) and the BTRY ALT (H-3) to keep the battery/observer/target relationship constant.

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
OBS DIR	C-4	Any	1. Depress matrix buttons C-4. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light. The number of the observer for whom data are being entered will appear in the right display window.) 3. On the keyboard, type the observer direction to the nearest mil (0 to 6400 mils).	1. Depress matrix buttons C-4. (Matrix window will light.) 2. Depress the RECALL key. (Observer direction will be displayed. See remark 3.)	1. This function is used to enter the azimuth in certain survey routines or to enter the observer direction in a polar plot mission. 2. Automatically set to minus zero during computation. 3. If two observer locations are used and an observer direction is entered for each, depressing the RECALL key the first time will cause the last observer direction entered to appear. Depressing the RECALL key the second time will cause the first observer direction entered to appear. In both cases, the number of the observer will also be displayed. 4. See SURVEY (D-5).
OBS HORIZ DIST	C-5	Any	1. Depress matrix buttons C-5. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light. The number of the observer for whom data are being entered will appear in the right display window.) 3. On the keyboard, type the observer horizontal distance to the nearest meter. 4. Depress the ENTER key.	1. Depress matrix buttons C-5. (Matrix window will light.) 2. Depress the RECALL key. (Distance will be displayed. See remark 3.)	1. Entry of this function destroys information entered for OBS SLANT DIST. 2. Automatically set to minus zero during computation. 3. Entry of data in C-6 (OBS SLANT DIST) sets this function (C-5) to minus zero. 4. If two observer locations are used and an observer horizontal distance is entered for each, depressing the RECALL key one time will cause the last observer horizontal distance entered to appear. Depressing the RECALL key the second time will cause the first observer horizontal distance entered to appear. In both cases, the number of the observer will also be displayed. 5. See SURVEY (D-5).
OBS SLANT DIST	C-6	Any	1. Depress matrix buttons C-6. (Matrix window will light.)	1. Depress matrix buttons C-6. (Matrix window will light.)	1. Entry of this function destroys information entered for OBS HORIZ DIST (C-5).

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
OBS SLANT DIST	C-6 (Cont)		2. Depress the SM key. (KEYBOARD indicator will light. The number of the observer for whom data are being entered will appear in the right display window.) 3. On the keyboard, type the observer slant range to the nearest meter. 4. Depress the ENTER key.	2. Depress the RECALL key. (Distance will be displayed. See remark 3.)	2. Automatically set to minus zero during computation. 3. Entry of data in C-5 (OBS HORIZ DIST) sets this function (C-6) to minus zero. 4. If two observer locations are used and the observer slant distance is entered for each, depressing the RECALL key the first time will cause the observer slant distance entered last to appear. Depressing the RECALL key the second time will cause the first observer slant distance entered to appear. In both cases, the number of the observer will also be displayed.
OBS VERT ANGLE	C-7	Any	1. Depress matrix buttons C-7. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light. The number of the observer for whom data are being entered will appear in the right display window.) 3. On the keyboard, type the observer vertical angle to the nearest mil (0 to ±1600 mils). 4. Depress the ENTER key.	1. Depress matrix buttons C-7. (Matrix window will light.) 2. Depress the RECALL key. (Sign and angle will be displayed. See remark 3.)	1. Sign (+ or -) must precede entry. 2. Automatically set to minus zero during computation. 3. If two observer locations are recalled sequentially and a vertical angle is entered for one observer location, depressing the RECALL key the first time will cause the vertical angle for the second observer location to appear. Depressing the RECALL key the second time will cause the vertical angle for the first observer location to appear. In both cases, the number of the observer location will also be displayed. The number +8192 will appear for that observer for which no vertical angle was entered. 4. See SURVEY (D-5).
POLAR PLOT MSN	C-8	Specific	1. Recall the observer location by following the procedure outlined for OBS LOC STORE (D-3), or enter observer location by following the procedures outlined for OBS EAST (C-1), OBS NORTH (C-2), and OBS ALT (C-3).	NA	1. Azimuth, distance, and vertical angle are automatically reset to minus zero during computation.

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
POLAR PLOT MSN	C–8 (Cont)		2. Depress matrix buttons C–8. (Matrix window will light.)		2. The vertical angle measured by the observer must be entered in order for the computer to display the correct target coordinates and altitude. If no angle is reported, enter +0 mils.
			★3. Depress the SM key. (COMPUTE indicator will light momentarily. Target coordinates and altitude will be displayed. The target easting northing, and altitude are stored in matrix positions A–1, A–2, and A–3, respectively. The OBS DIR is stored as OT DIR.)		3. If the observer reports the vertical displacement as a shift in meters, enter the vertical angle as +0 and enter the vertical shift by using the UP/DOWN function (A–8). The computer will display the target coordinates and the observer altitude; however, the computer will use the target coordinates and target altitude in solving the ballistic trajectory.
M36 CHRON	D–1	Any	1. Depress the appropriate series weapon button (1 or 2).	NA	1. This function is used to enable the chronograph extrapolation program or to dismiss the chronograph program and return to the cannon program.
			2. Depress matrix buttons D–1. (Matrix window will light.)		2. The following matrix functions are controlled by the chronograph routine: B–1 (CHG) B–3 (WHITE CHG 3, 4, 5) B–5 (PROJ TYPE) D–2 (% DEN DELAY) G–1 (MV) G–2 (POWD TEMP) G–3 (PROJ WEIGHT) G–8 (QE INPUT)
			3. Depress the SM key. (KEYBOARD indicator will light.)		3. In some cases, input values for the chronograph program will be entered by using entry procedures different from those used in the cannon program.
			4. On the keyboard, type 0 to enable the chronograph extrapolation program; type 9 to dismiss the chronograph routine and return to the cannon program.		
% DEN DELAY	D–2	Any	1. Depress matrix buttons D–2. (Matrix window will light.)	1. Depress matrix buttons D–2. (Matrix window will light.)	1. This function is used only to enter data for use in the chronograph extrapolation program.

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
% DEN DELAY	D–2 (Cont)		2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (KEYBOARD indicator will light.)	2. Typing 1 on the keyboard indicates that the entry is density to the nearest 0.1 percent. Density in percentage of standard is extracted from the 00 line of the NATO standard met message.
			3. On the keyboard, type 1 and depress the ENTER key. (KEYBOARD indicator will remain on.) On the keyboard, type the value of density in percentage of standard to the nearest 0.1 percent and depress the ENTER key. (Typing 2 on the keyboard will indicate that the entry is a delay gate setting (range of entry 1–10). Delay switch setting will be obtained from the M36 chronograph operator.)	3. On the keyboard, type 1 to recall density or 2 to recall the delay gate setting.	
				4. Depress the ENTER key.	
OBS LOC STORE	D–3	Any	1. Enter the easting, northing, and altitude of the observer's position by following the procedures outlined for OBS EAST (C–1), OBS NORTH (C–2), and OBS ALT (C–3).	1. Depress matrix buttons D–3. (Matrix window will light.)	1. Until changed by the operator, the computer will associate the observer's location with the number assigned in step 4, entry procedure.
			2. Depress matrix buttons D–3. (Matrix window will light.)	2. Depress the RECALL key. (KEYBOARD indicator will light.)	2. See SURVEY (D–5).
			3. Depress the SM key. (KEYBOARD indicator will light.)	3. On the keyboard, type the number of the observer to be recalled.	
			4. On the keyboard, type the assigned number of observer (1 to 9).	4. Depress the ENTER key. (Observer coordinates, altitude, and number will be displayed.)	
			5. Depress the ENTER key. (Observer coordinates and altitude will be displayed in appropriately marked windows. Assigned observer number will be displayed in CHARGE window.		
CLEAR MEMORY	D–4	Any	★1. If the PARITY indicator flickers, test the working storage by following the procedures outlined in paragraph 2–14*b*. (Computer will display the line of	NA	1. This function is used to return a selected line of working storage to the state it was in after the program was entered with the signal data reproducer AN/GSQ–64. The necessity for using this

			memory in which the PARITY error occurred.) 2. Enter the proper section of clear memory tape into the mechanical tape reader. This can be determined by comparing the number at beginning of tape section with the line number displayed by the computer in step 1. 3. Depress matrix buttons D–4. (Matrix window will light.) 4. Depress the SM key. (KEYBOARD indicator will light.) 5. On the keyboard, type the line number displayed by the computer after the working storage test made in step 1. 6. Depress the ENTER key. The computer will read the proper section of tape through the mechanical tape reader. 7. Refer to map of working storage (fig 2–14) to determine the data stored in cleared line. 8. Reenter data into the cleared line by following the normal entry procedure. 9. Repeat steps 1 through 8 until the test of working storage is successful.	function will be indicated by a blinking PARITY indicator. 2. If the program test of working storage is successful, number 136 will be displayed. When the trouble is not in working storage, the program should be reloaded with the signal data reproducer AN/GSQ–64. 3. The clear memory tape consists of sections of tape for each line of memory. At the beginning of each section of tape the number of the line of memory is written. The computer will accept only the section of tape specified by the keyboard input. ★4. See the procedure for entering the tape into the mechanical tape reader, paragraph 2–18.
SURVEY	D–5	Any	1. The procedure for solving a traverse is as follows: *a.* Using matrix buttons C–1, C–2, or C–3, enter or recall the starting coordinates and altitude of the initial traverse station.	1. This function is used to cause the computer to solve any of the following survey routines to the limited accuracy required in the FDC. They are as follows: *Survey routines* — *Flag* *a.* Traverse .... 1 *b.* Intersection .... 2 *c.* Orientation .... 3 *d.* Zone-to-zone transformation 4

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
SURVEY	D-5 (Cont)		(1) To enter the starting coordinates and altitude of the traverse, follow the procedures outlined for OBS EAST (C-2), and OBS ALT (C-3). (2) To recall the starting coordinates and altitude of the traverse, follow the recall procedures outlined for OBS LOC STORE (D-3). ★*b.* Using matrix buttons C-4, C-5, or C-6, and C-7, enter the direction, the horizontal or slant distance, and the vertical angle to the forward station of the traverse by following the procedures outlined for OBS DIR (C-4), OBS HORIZ DIST (C-5) or OBS SLANT DIST (C-6), and OBS VERT ANGLE (C-7). The direction, the distance, and the vertical angle must be entered for each leg. *c.* Depress matrix buttons D-5. (Matrix window will light.) *d.* Depress the SM key. (KEYBOARD indicator will light.) *e.* On the keyboard, type 1. *f.* Depress the ENTER key. (KEYBOARD light will go out. COMPUTE indicator will light. Coordinates and altitude of forward station will be displayed in appropriate windows, and 0 will be displayed in the CHARGE window.) *g.* To compute the next leg of the traverse, return to step *b* above.		

2. The procedure for solving an intersection is as follows:

a. Recall the coordinates and altitude of the first observer by following the recall procedure outlined for OBS LOC STORE (D–3).

b. Enter the azimuth from the first observer to the unknown station by following the procedure outlined for OBS DIR (C–4). If this observer measured the vertical angle, enter the vertical angle by following the procedure outlined for OBS VERT ANGLE (C–7). The vertical angle can be entered for only one observer.

c. Recall the location and altitude of the second observer as outlined in *a* above.

d. Enter the azimuth and vertical angle (if applicable) from the second observer to the unknown station as outlined in *b* above.

e. Depress matrix buttons D–5. (Matrix window will light.)

f. Depress the SM key. (KEYBOARD indicator will light.)

g. On the keyboard, type 2.

h. Depress the ENTER key. (KEYBOARD indicator will go out, COMPUTE indicator will light, coordinates and altitude of the unknown point will be displayed.)

3. The procedure for computing the orienting data for two observers to a target is as follows:

a. Using the appropriate matrix positions, enter or recall the target coordinates and altitude.

(1) To enter the target coordinates and altitude, follow the procedure outlined for TGT-EAST

2. For greater accuracy in the survey routines, data may be entered to a fraction of a mil or meter.

3. The survey routines produce accurate results for use in fire direction; however, the higher order accuracy required in extended survey control operations should not be expected from the cannon program survey routines. When greater accuracy is required, solutions should be computed with the survey programs available to the SIC at corps or division artillery headquarters.

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
SURVEY	D-5 (Cont)		(A-1), TGT NORTH (A-2), and TGT ALT (A-3). (2) To recall the target coordinates and altitude, follow the recall procedure outlined for TGT STORE (A-4). *b.* Recall the coordinates and altitude of the first observer by following the recall procedure outlined for OBS LOC STORE (D-3). *c.* Recall the coordinates and altitude of second observer by following the recall procedure outlined for OBS LOC STORE (D-3). *d.* Depress matrix buttons D-5. (Matrix window will light.) *e.* Depress the SM key. (KEYBOARD indicator will light.) *f.* On the keyboard, type 3. *g.* Depress the ENTER key. (KEYBOARD indicator light will remain on; the direction, distance, and vertical angle from one observer to the target will be displayed in the appropriate windows; and the number of the observer will be displayed in the CHARGE window.) *h.* Depress the ENTER key again. (KEYBOARD indicator light will go out; the orienting data for the other observer will be displayed as described in *g* above). *Note.* The orienting data for the second observer will be displayed first. 4. The procedure for computing the zone-to-zone transformation of coordinates is as follows:		

★*a.* Using matrix locations E–5, E–6, E–7 and E–8, enter the appropriate data.

b. Depress matrix buttons D–5. (Matrix window will light.)

c. Depress the SM key. (KEYBOARD indicator will light.)

d. On the keyboard, type 4 and depress the ENTER key. (The KEYBOARD indicator will remain on.)

(1) If the coordinates being transformed are a *target*, depress the 1 key (or any odd numbered key). The COMPUTE indicator will light and the transposed coordinates and azimuth will be displayed and automatically entered in matrix locations A–1, A–2, and A–5.

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
SURVEY	D-5 (Cont)		*Note.* The target altitude is normally determined from the VCO chart and should be entered through matrix location A-3 (TGT ALT) before firing data are computed or before the target is stored on the target list. (2) If the coordinates being transformed are an observer's location, depress the 2 key (or any even-numbered key), the COMPUTE indicator will light and the transposed coordinates and azimuth will be displayed and automatically entered in matrix locations C-1, C-2, and C-4. *Note.* The observer's altitude is determined from the VCO chart or reported by the observer. It must be entered by using matrix location C-3 (OBS ALT) before those data are stored.		
TEMP MSN STORE	D-6	Specific	1. Insure that the appropriate battery button is depressed. 2. Depress matrix buttons D-6. (Matrix window will light.) 3. Depress the SM key. (KEYBOARD indicator will light.) 4. On the keyboard, depress 0.	1. Insure that the battery button for which the mission was stored is depressed. 2. Depress matrix buttons D-6. (Matrix window will light.) 3. Depress the RECALL key. 4. On the keyboard, depress 0. (Target coordinates will be displayed and all mission overrides and data will be reentered automatically.)	1. Target data corresponding to the battery button depressed will be stored temporarily. 2. All overrides and observer-target direction for the mission will be stored temporarily. 3. If this function has been selected and the SM or RECALL key has been depressed, the function can be dismissed by depressing a 9 on the keyboard.
REPLOT POLAR	D-7	Specific	1. Depress matrix buttons D-7. (Matrix window will light.) 2. Depress the SM key. (Azimuth, range, and vertical angle from the selected battery to the target will be displayed.)	NA	1. Must be preceded by REPLOT RECT (D-8) if registration corrections are being used. 2. NO SOLUTION indicator will blink if REPLOT POLAR function has not been preceded REPORT RECT as a warning to indicate that the result is not precisely correct if registration corrections are being used.

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
REPLOT POLAR	D-7 (Cont)				3. Last ballistic trajectory computed will be used for replot. 4. 20/R will be automatically removed in the case of fuze VT and fuze time trajectories.
REPLOT RECT	D-8	Specific	1. Depress matrix buttons D-8. 2. Depress the SM key. (The computer will display the target coordinates used to establish the trajectory which hit the target. The KEYBOARD indicator will remain on.) 3. Compare the target altitude displayed with the altitude at the same location shown on a map of the area. If there is a difference in the altitudes, enter the map altitude. The CLEAR key may be depressed before the altitude is entered. 4. After the new altitude has been entered, the computer will display new coordinates and altitude. If they do not compare favorably, perform step 3. If the altitudes agree, the target is properly located and may be stored by TGT STORE (A-4) procedure. 5. On the keyboard, depress the decimal point key to terminate mode.	NA	1. Used to successively approximate the target altitude after adjusting the original target location. 2. If the final replot location of the target crosses a UTM 100,000-meter grid line from the original target location so that the five-digit easting or northing is increased to a value greater than 99999, the displayed coordinates cannot be stored directly by using matrix function A-4 (TGT STORE). When this situation occurs, manually record the final replot coordinates, end the mode, and reenter the coordinates in matrix functions A-1, A-2, and A-3; then store these data by using function A-4.
EOM	E-1	Specific	1. Depress matrix buttons E-1. (Matrix window will light.)	NA	1. Used to end mission and dismiss data associated with that mission.

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
	★E–1 (Cont)		2. Depress the SM key. (KEYBOARD indicator will light.)		2. Computer automatically dismisses— *a.* CHG (B–1) override. *b.* HI ANGLE (B–2). *c.* WHITE CHG 3, 4, 5 (B–3). *d.* GT LINE ADJUST (B–4).
			3. Depress 0. (KEYBOARD indicator light will go out.)		3. Computer automatically sets— *a.* PROJ TYPE (B–5) to HE. *b.* FUZE TYPE (B–6) to Q. *c.* MAX ORD (E–3) and HOB (B–7) to minus zero. *d.* TGT EAST (A–1), TGT NORTH (A–2), TGT ALT (A–3), and OT DIR (A–5) to minus zero. *e.* DF INPUT (G–6), TIME INPUT (G–7), and QE INPUT (G–8) to minus zero. 4. If this function has been selected and the SM key has been depressed, the function can be dismissed by entering 9 or by depressing the RESET button.
SET UP	E–2	Specific	1. Depress matrix buttons E–2. (Matrix window will light.)	NA	1. As soon as the program has been loaded, this function must be used to designate to the computer the applicable portion of the program for the selected caliber or series of weapon.
			2. Depress the button to select the desired battery.		2. All constants pertaining to the battery selected in entry procedure step 2 are set to standard. These constants are muzzle velocity, projectile weight, and powder temperature.
			★3. Designate caliber of battery selected in step 2 by depressing either the 1 or the 2 button. (See paragraph 2–12 for explanation of caliber of series of weapon designation by buttons 1 and 2).		3. All registration corrections for the battery selected are set to zero.
			4. Depress the SET UP button. (COMPUTE indicator will light momentarily.)		
			5. When the COMPUTE indicator goes out, return to step 2 to set up other batteries.		

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
★MAX ORD	E-3	Any	N/A	1. Depress matrix buttons E-3. (Matrix window will light.) 2. Depress the RECALL key. (The maximum ordinate will be displayed for the last computed trajectory.)	1. This function is used to determine the maximum ordinate of the trajectory that will result from firing the displayed gun data. 2. Ordinate will be displayed to the nearest meter above sea level. 3. This function is set to minus zero by function E-1 (EOM).
★MET INPUT	E-4	Any	1. Keyboard entry procedures are as follows: *a.* Depress matrix buttons E-4. (Matrix window will light.) *b.* Depress the SM key. (KEYBOARD indicator will light.) *c.* On the keyboard, type 0 and depress the ENTER key; the number 88 will be displayed. *d.* On the keyboard, type the identification line (12 digits) of the met message, starting with the data-valid time group, as follows: 2 digits (day of month) 3 digits (time validity begins) 1 digit (number of hours the data will be valid) 3 digits (height of MDP above mean sea level in decameters) 3 digits (pressure in millibars) *Note.* The Nixie display will appear in the following formats: Abx xxxxx xxxxx xbbbb A = letter indicating which battery button was depressed b = unlit Nixie x = number Depress the Enter key. The computer will then demand line 00. (00 will be displayed.) *e.* On the keyboard, type the 00 line (16 digits) as follows: 2 digits (00) 3 digits (wind direction to the nearest 10 mils) 3 digits (wind speed to the nearest knot)	1. Depress matrix buttons E-4. (Matrix window will light.)	1. This function is used to enter the meteorological message. Met data in the form of a computer met message are entered through the keyboard; data in paper tape form are entered through the mechanical tape reader.

4 digits (temperature in degrees Kelvin to the nearest 0.1 degrees) (do not enter the decimal point.) 4 digits (pressure to the nearest millibar) *f.* Depress the ENTER key. The computer will then demand line 01 (01 will be displayed). *g.* Enter each of the remaining lines in same manner as that used for line 00. A maximum of 26 lines can be entered. When the last line has been entered, terminate the input mode by typing 9 (or a decimal point) and depressing the ENTER key. If the maximum number of lines is entered, the input mode will be automatically terminated.		
2. If a mistake made in any line entry is discovered after the mode has been terminated, a correction can be made as follows: *a.* Depress the SM key. *b.* On the keyboard, type 2 and depress the ENTER key. (KEYBOARD indicator will remain lighted.) *c.* On the keyboard, type the number of the line to be reentered. (The line number will be displayed.) *d.* On the keyboard, type the correct 16-digit line.	2. Depress the RECALL key. (Line number will be displayed.)	2. Function H–6 (MET STD) should be used before a current met message is entered by using the MET INPUT function to insure that all old or invalid met data have been deleted.
3. The procedure for entering a met message tape is as follows: ★*a.* Load the tape into the tape reader. (See paragraph 2–18 for procedure used to enter tape). *b.* Depress matrix buttons E–4. (Matrix window will light.) *c.* Depress the SM key. (KEYBOARD indicator will light.)	★3. If a specific line of met data is to be recalled, on the keyboard type the line number. The line number will be displayed. Terminate the recall mode by entering the figure line (9).	★3. The met message must always be entered *after* the A battery altitude has been entered. Whenever the altitude for A battery is entered or reentered subsequent to entering a current met message, the met ID line must be reentered. Further, whenever met is set to standard, a 12-digit zero ID line (e.g. 000000 000000) must be entered to correctly establish the metro datum plane (MDP) altitude for standard met.

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
MET INPUT	E-4 (Cont)		*d.* On the keyboard, type 3 and depress the ENTER key. (The reader will automatically feed the tape and end the mode.) If the computer does not accept a line of the met message through the tape reader, it will display the line number of the met message on which it has stopped, and the KEYBOARD indicator will light. Then the remainder of the met message may be entered manually by following the procedure outlined in steps 1e and g (starting with the line displayed).		
ZONE 1 TO ZONE 2	E-5	Any	1. Depress matrix buttons E-5. (Matrix window will light.)	1. Depress matrix buttons E-5. (Matrix window will light.)	1. This function is used only to enter the UTM zone numbers used in transformation of coordinates from an adjacent zone to a local zone.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (KEYBOARD indicator will light.)	2. Matrix functions E-6, E-7, E-8, and D-5 must also be used to enter the complete data needed in the solution of the zone-to-zone transformation problem.
			3. On the keyboard, type 1 and depress the ENTER key. (KEYBOARD indicator will remain on.)	3. On the keyboard, type 1 or 2 to identify either local or adjacent zone.	3. Range of input is from ±1 to ±60.
			★4. On the keyboard, type the adjacent UTM grid zone number preceeded by a sign (+ or −) to indicate the hemisphere. + = Northern Hemisphere − = Southern Hemisphere	4. Depress the ENTER key; the UTM grid zone number will be displayed in the following format: ±XX.OO	4. The entered value will be set to minus zero during computations with matrix function D-5 (SURVEY).
			5. Depress the ENTER key. (KEYBOARD indicator will go out.)		5. The zone-to-zone transformation routine will produce a solution only for transformation from one adjacent grid zone to another. The grid zone being used for primary control is known as the local zone. The coordinates being transformed are considered to be in the adjacent zone.
			6. Depress the SM key. (KEYBOARD indicator will light.)		

			7. On the keyboard, type 2 and depress the ENTER key. (KEYBOARD indicator will go out.) ★8. On the keyboard, type the local UTM grid zone preceded by a sign (+ or −) to indicate the hemisphere as described in step 4 above. 9. Depress the ENTER key. 10. Continue the problem solution by using matrix locations E–6, E–7, E–8, and D–5.		
STA EAST	E–6	Any	1. Depress matrix buttons E–6. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the easting coordinate of the station to be transformed. Enter six digits to identify the 100,000-meter grid square. 4. Depress the ENTER key.	1. Depress matrix buttons E–6. (Matrix window will light.) 2. Depress the RECALL key. (The last entered data will be displayed.)	1. This function is used only to enter the UTM easting coordinate of the STA to be transformed to the local grid zone in the zone-to-zone transformation routine. 2. Range of input is from 100,000 to 899,999. 3. The entered value will be set to minus zero during computations with matrix function D–5 (SURVEY).
STA NORTH	E–7	Any	1. Depress matrix buttons E–7. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the northing coordinate of the station to be transformed. Enter seven digits to identify the 100,000-meter grid square. 4. Depress the ENTER key.	1. Depress matrix buttons E–7. (Matrix window will light.) 2. Depress the RECALL key. (The last entered data will be displayed.)	1. This function is used only to enter the UTM northing coordinate of the STA to be transformed to the local grid zone in the zone-to-zone transformation routine. 2. Range of input is from 0000000 to 9,999,999. 3. The entered value will be set to minus zero during computations with matrix function D–5 (SURVEY).
SPHERE/AZ	E–8	Any	1. Depress matrix buttons E–8. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.)	1. Depress matrix buttons E–8. (Matrix window will light.) 2. Depress the RECALL key. (The last input data will be displayed.)	1. This function is used only to enter the number indicating the mapping spheroid to be used in the zone-to-zone transformation routine and the azimuth (to the nearest mil) to be transformed. 2. Range of spheroid input is from 1 to 5; range of azimuth input is from 1 to 6400.

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
SPHERE/AZ	E–8 (Cont)		3. On the keyboard, type the spheroid number: *Spheroid* — *Flag* Clarke 1866 .... 1 International .... 2 Clarke 1880 .... 3 Everest .... 4 Bessel 5		3. The direction north can be input only as 6400. An input of 0 deletes the azimuth transformation requirement.
			4. Depress the ENTER key. (KEYBOARD indicator will remain on.)		4. The entered value will be set to minus zero during computations with matrix function D–5 (SURVEY).
			5. On the keyboard, type the azimuth to be transformed. If no azimuth is to be entered, type 0. 6. Depress the ENTER key.		
NO FIRE AREA EAST	F–1	Any	1. Depress matrix buttons F–1. (Matrix window will light.)	1. Depress matrix buttons F–1. (Matrix window will light.)	1. This function is used to enter the easting coordinate of the center of a no-fire area.
			2. Depress the SM key. (KEY BOARD indicator will light.)	2. Depress the RECALL key. (Easting will be displayed.)	2. A five-digit entry is required.
			3. On the keyboard, type the area easting to the nearest meter. 4. Depress the ENTER key.		3. Easting should not be entered as 00000 except for clearing a specific no-fire area. In such event, enter 00001.
NO FIRE AREA NORTH	F–2	Any	1. Depress matrix buttons F–2. (Matrix window will light.)	1. Depress matrix buttons F–2. (Matrix window will light.)	1. This function is used to enter the no-fire area northing coordinate.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (Northing will be displayed.)	2. A five-digit entry is required.
			3. On the keyboard, type the area northing to the nearest meter. 4. Depress the ENTER key.		
NO FIRE AREA RADIUS	F–3	Any	1. Depress matrix buttons F–3. (Matrix window will light.)	1. Depress matrix buttons F–3. (Matrix window will light.)	1. This function is used to enter the no-fire area safe radius.
			2 Depress the SM key.	2. Depress the RECALL key. (Safe radius will be displayed.)	2. A radius greater than 20,000 meters should not be entered.
			3. On the keyboard, type the area safe radius to the nearest meter (1 to 20,000).		3. Safe radius values should be calculated as described in paragraph 2–27.
					★4. If more than one safe radius is applicable to the same area, see remark 4 for matrix location F–4 (NO FIRE AREA STORE).

★NO FIRE AREA STORE	F-4	Any	1. After no-fire area data have been entered with matrix functions F-1 (NO FIRE AREA EAST), F-2 (NO FIRE AREA NORTH), and F-3 (NO FIRE AREA RADIUS), depress matrix button F-4. (Matrix window will light.)	1. Depress matrix buttons F-4. (Matrix window will light.)	1. This function is used to store or recall the easting, northing, and safe radius entered in locations F-1, F-2, and F-3. Up to 39 no-fire areas can be stored.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (KEYBOARD indicator will light.)	2. A specific no-fire area can be deleted from the list by entering 00000 in matrix positions F-1, F-2, and F-3 and then following the entry procedure for this function.
			3. On the keyboard, type the file number (1 to 39) assigned to the no-fire area.	3. On the keyboard, type the file number of the area to be recalled.	★3. All no-fire areas can be cleared by depressing (.) (.), decimal point, twice in steps 3 and 4 of the entry procedure and then depressing the ENTER key.
			4. Depress the ENTER key. (The COMPUTE indicator will light momentarily and the coordinates and safe radius of the area will be displayed.)	4. Depress the ENTER key. The no-fire area coordinates and radius will be displayed and automatically entered in the F-1, F-2, and F-3 locations.	4. When the areas entered are to be checked for two different types of shells with different safe radii, the areas deserted by the smaller radius for one type of shell must be stored first on the list; then, all areas for the second type shell with a larger safe radius will be stored last.
				★5. To determine which area is causing the NO SOLUTION indicator to blink, follow steps 1 and 2 above and type file number 40 in step 3. When the ENTER key is depressed, the number of the area will be displayed.	
	F-5		NOT USED		
DF CORR	F-6	Specific	1. Depress matrix buttons F-6. (Matrix window will light.)	1. Depress matrix buttons F-6. (Matrix window will light.)	1. This function is used to enter a deflection correction for a specific charge for a designated battery.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (KEYBOARD indicator will light.)	2. When corrections are computed with H-8 (COMP REG), the deflection correction will be automatically entered for the battery or batteries designated. If function F-6 is used, care must be taken to insure that the correction is valid. See remark 4 under matrix location H-8 (COMP REG).

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
DF CORR	F–6 (Cont)		3. On the keyboard, type the applicable charge and depress the ENTER key. (KEYBOARD indicator will remain on.) 4. On the keyboard, type the direction of the deflection correction. (LEFT or RIGHT) and the amount of the deflection correction and depress the ENTER key.	3. On the keyboard, type the applicable charge and depress the ENTER key. (Deflection correction will be displayed.)	
TIME CORR	F–7	Specific	1. Depress matrix buttons F–7. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the applicable charge and depress the ENTER key. (KEYBOARD indicator will remain on.) 4. On the keyboard, type the time correction preceded by sign (+ or −) and depress the ENTER key.	1. Depress matrix buttons F–7. (Matrix window will light.) 2. Depress the RECALL key. (KEYBOARD indicator will light.) 3. On the keyboard, type the applicable charge and depress the ENTER key. (Time correction will be displayed.)	1. This function is used to enter a time correction for a specific charge for a designated battery. ★2. When corrections are computed by using H–8 (COMP REG), this time correction will be automatically entered for the battery or batteries designated. If function F–7 is used, care must be taken to insure that the correction is valid. See remark 4 under matrix location H–8 (COMP REG).
RANGE/K	F–8	Specific	1. Depress matrix buttons F–8. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.)	1. Depress matrix buttons F–8. (Matrix window will light.) 2. Depress the RECALL key. (KEYBOARD indicator will light.)	1. This function is used to enter a variable range K for a specific charge for a designated battery. 2. When corrections are computed by using H–8 (COMP REG), the variable range K will be automatically entered for the battery or batteries designated. Care must be exercised when this function is used to insure the correction is a valid one based on the ballistic parameters that are entered in the M18 computer. See remark 4 under matrix location H–8 (COMP REG).

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
RANGE/K	F-8 (Cont)		3. On the keyboard, type the applicable charge and depress the ENTER key. (KEYBOARD indicator will remain on.) 4. On the keyboard, type the range at which the correction was determined and depress the ENTER key. (KEYBOARD indicator will remain on.) 5. On the keyboard type the value of range K preceded by a plus or minus sign (+ or–) and depress the ENTER key.	3. On the keyboard, type the applicable charge and depress the ENTER key. (The value of range K and the entered range will be displayed.)	
MV	G-1	Specific	1. Depress matrix buttons G-1. (Matrix window will light.)	1. Depress matrix buttons G-1. (Matrix window will light.)	1. This function is used to enter the MV developed in the cannon program or in the chronograph extrapolation program.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (KEYBOARD indicator will light.)	2. Example of flag entry: *Description* — *Flag* Shell HE, chg 2 12
			3. On the keyboard, type in a flag of two digits. The first digit will be the projectile type flag and the second digit will be the charge flag. (KEYBOARD indicator will remain on.) (See appendix C for appropriate flag.)	3. On the keyboard, type the flag as outlined in step 3, entry procedure. (MV will be displayed.)	3. See appendix C for standard muzzle velocities.
			4. Depress the ENTER key.	4. Depress the ENTER key.	4. If a nonstandard muzzle velocity is entered for shell HE, WP, smoke, or gas for the 105-mm or 155-mm howitzer, the computer will automatically apply the muzzle velocity entered to the other projectiles of this group. Other projectile types identified by "flags" 4, 5, 6, 7, or 8 require a specific MV entry.
			5. Omit step 3 and 4 in the chronograph extrapolation mode.		5. To enter nonstandard muzzle velocities for charges 3, 4, and 5, white bag, first use function B-3 with an enabling entry of 0.
			6. On the keyboard, type the muzzle velocity to the nearest 0.1 meter per second. 7. Depress the ENTER key.		

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
POWD TEMP	G–2	Specific	1. Depress matrix buttons G–2. (Matrix window will light.)	1. Depress matrix buttons G–2. (Matrix window will light.)	1. This function is used to enter powder temperature for either the cannon program or the chronograph extrapolation routine.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (Powder temperature will be displayed.)	2. The entry of powder temperature for use in the cannon program does not interfere with the data entered for use in the chronograph extrapolation routine and vice versa.
			3. On the keyboard, type the sign and numerical value of the powder temperature to the nearest degree Fahrenheit.		
			4. Depress the ENTER key.		
PROJ WEIGHT	G–3	Specific	1. Depress matrix buttons G–3.	1. Depress matrix buttons G–3.	1. This function is used to input projectile weight in both the cannon program and the chronograph extrapolation routine.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (KEYBOARD indicator will light.)	2. Minor differences will occur between inputs and recall of inputs, since the computer uses the projectile weight to the nearest one-sixteenth pound.
			3. On the keyboard, type the digit (flag) for the projectile type desired (app C & F) and depress the ENTER key. (KEYBOARD indicator will light.	3. Enter the digit (flag) for the projectile to be recalled. (The stored weight for the projectile desired will be displayed.)	3. See appendix C for standard projectile weights.
			4. On the keyboard, type the projectile weight to the nearest 0.1 pound.	4. Omit step 3 in the chronograph extrapolation mode.	
			5. Omit step 3 in the chronograph extrapolation mode.		
			6. Depress the ENTER key.		
LAT	G–4	Any	1. Depress matrix buttons G–4. (Matrix window will light.)	1. Depress matrix buttons G–4. (Matrix window will light.)	1. Enter a plus sign if the battery is located in the Northern Hemisphere or a minus sign if the battery is located in the Southern Hemisphere.
			2. Depress the SM key. (KEYBOARD indicator will light.)	2. Depress the RECALL key. (Latitude will be displayed.)	2. The latitude entered for one battery will be applied to all batteries.
			3. On the keyboard, type the sign and numerical value to the battery latitude to the nearest degree (0 to ±90).		3. This latitude entry is used in the ballistic routine.
			4. Depress the ENTER key.		

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
GRID DECL	G–5	Any	1. Depress matrix buttons G–5. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the sign and numerical value of the grid declination angle to the nearest mil (0 to ±63 mils). 4. Depress the ENTER key.	1. Depress matrix buttons G–5. (Matrix window will light.) 2. Depress the RECALL key. (Grid declination angle will be displayed.)	1. This function is used to convert the wind azimuth from true north to grid north. If grid north is to the right of true north, the sign will be plus; if grid north is to the left of true north, the sign will be minus. 2. If no entry is made, the computer will assume that the grid declination angle is 0. 3. This function must be entered before MET INPUT (E–4) is used.
DF INPUT	G–6	Specific	1. Depress matrix buttons G–6. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the adjusted deflection to the nearest mil. 4. Depress the ENTER key.	1. Depress matrix buttons G–6. (Matrix window will light.) 2. Depress RECALL key. (Deflection input will be displayed.)	1. This function is used to enter the adjusted deflection after a registration. The adjusted deflection is used by the computer to determine the deflection correction. 2. Values will be set to minus zero by E–1 (EOM).
TIME INPUT	G–7	Specific	1. Depress matrix buttons G–7. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the adjusted fuze setting to the nearest 0.1 second. 4. Depress the ENTER key.	1. Depress matrix buttons G–7. (Matrix window will light.) 2. Depress the RECALL key. (Time input will be displayed.)	1. Values will be set to minus zero by E–1 (EOM). 2. This function is used to enter the adjusted time after a registration. The adjusted time will be used by the computer to determine the fuze correction.
QE INPUT	G–8	Specific	1. Depress matrix buttons G–8. (Matrix window will light.) 2. Depress SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the QE to the nearest mil. 4. Depress the ENTER key.	1. Depress matrix buttons G–8. (Matrix window will light.) 2. Depress RECALL key. (QE input will be displayed.)	1. This function is used in the cannon program to enter the adjusted QE after a registration or in the chronograph extrapolation program to enter the QE fired. 2. Values will be set to minus zero by E–1 (EOM) in the cannon program and by D–1 (M36 CHRON) in the chronograph routine.

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
BTRY EAST	H–1	Specific	1. Depress matrix buttons H–1. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type to the nearest meter. 4. Depress the ENTER key.	1. Depress matrix buttons H–1. (Matrix window will light.) 2. Depress the RECALL key. (Battery easting will be displayed.)	Five-digit coordinates must be used. If not, the NO SOLUTION indicator will flicker and the display will remain.
BTRY NORTH	H–2	Specific	1. Depress matrix buttons H–2. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the battery northing to the nearest meter. 4. Depress the ENTER key.	1. Depress matrix buttons H–2. (Matrix window will light.) 2. Depress the RECALL key. (Battery northing will be displayed.)	Five-digit coordinates must be used. If not, the NO SOLUTION indicator will flicker and the display will remain.
BTRY ALT	H–3	Specific	1. Depress matrix buttons H–3. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the altitude to the nearest meter. 4. Depress the ENTER key.	1. Depress matrix buttons H–3. (Matrix window will light.) 2. Depress the RECALL key. (Battery altitude will be displayed.)	1. Used to enter the altitude of the battery above sea level. 2. Negative inputs will not be accepted. 3. In the event the battery is below sea level, relative altitudes should be used for the target and battery by adding a constant value to the altitude of each before entering the data into FADAC. 4. If the battery is below sea level, add a sufficient amount to the true altitude to change the value from minus (–) to plus (+). An equal amount must be added to the TGT ALT (A–3) and OBS ALT (C–3) to keep the battery/observer/target altitude relationship constant.
BTRY AZ LAID	H–4	Specific	1. Depress matrix buttons H–4. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the battery azimuth to the nearest mil. 4. Depress the ENTER key.	1. Depress matrix buttons H–4. (Matrix window will light.) 2. Depress the RECALL key. (Battery azimuth will be displayed.)	

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
BTRY DF	H–5	Specific	1. Depress matrix buttons H–5. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the referred deflection to the nearest mil. 4. Depress the ENTER key.	1. Depress matrix buttons H–5. (Matrix window will light.) 2. Depress the RECALL key. (Battery referred deflection will be displayed.)	
MET STD	H–6	Any	1. Depress matrix buttons H–6. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, depress 0. (KEYBOARD indicator light will go out; COMPUTE indicator will flash.)	NA	1. This function deletes the most recent met input and replaces it with standard values. 2. This function may be dismissed by depressing a 9 instead of 0 in step 3 of the entry procedure. ★3. See Remark 3, opposite function E–4 (MET INPUT).
ZERO CORR	H–7	Specific	1. Depress matrix buttons H–7. (Matrix window will light.) 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, depress 0. (KEYBOARD indicator light will go out; COMPUTE indicator will flash.)	NA	1. This function deletes all registration corrections for the battery designated by depressing the battery button. 2. Entering 9 instead of 0 in step 3 of the entry procedure will dismiss this function without setting the registration corrections to zero. 3. The setup procedure outlined under SET UP (E–2) will also set all registration corrections to zero for the battery selected. ★4. Selection of COMP REG (H–8) will automatically set all previous registration corrections to zero for the battery selected and the charge being used.
COMP REG	H–8	Specific	1. The procedure for computing the corrections for both a precision registration and a time registration is as follows: *a. Conduct of registration.* The computer is used to compute the firing data for the adjustment phase only. The steps are as follows:	NA	1. This function is used to determine the registration corrections after a precision, time, high-burst, or mean-point-of-impact registration. ★2. Selection of this function automatically zeros all previous registration corrections for the battery selected and the charge being used.

Table 2-1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
COMP REG	H-8 (Cont)		(1) Select the battery to which the corrections will apply by depressing the battery button. (2) Recall or enter the coordinates and altitude of the registration point by following the recall procedures for TGT STORE (A-4) or the entry procedures for TGT EAST (A-1), TGT NORTH (A-2), and TGT ALT (A-3). (3) A specific charge must be selected for the registration by the procedure outlined for CHG (B-1). (4) Compute the firing data in the normal manner for the adjustment phase. (5) Upon entering fire for effect, complete the firing data by using the procedures described in FM 6-40 and on DA Form 6-12 (Record of Precision Fire). (See remark 6.) *b. Computation of registration corrections.* The computer is used to compute the registration corrections and apply them to subsequent computations as follows: (1) Reenter the coordinates and altitude of the registration point. (2) Enter the adjusted deflection, adjusted time (time registration only), and adjusted QE as outlined in the entry procedures for DF INPUT (G-6), TIME INPUT		3. If the base piece is displaced from the battery center, the coordinates and altitude of the base piece must be entered instead of the coordinates and altitude of the battery center before computing the registration. After the registration corrections have been displayed and entered, the coordinates and altitude of the battery center should be reentered for future firing. In this way the computer will automatically correct for base piece displacement. These corrections may then be transferred to other batteries without regard to base piece displacement. 4. The registration corrections displayed by the computer are the residual corrections between the data required to hit the registration point (adjusted data) and the data the computer would have determined to hit that point by using the parameters for weather and materiel which were entered into the computer. These corrections are not the same as those used in manual computations, since there is no way to graphically separate the corrections. They exclude factors, such as drift, that are automatically included by the computer. The corrections displayed by the computer are described below: *a.* The deflection correction will be displayed to the nearest mil in the DEFLECTION window. The direction (sign) of the correction will appear in the SIGN window. A plus sign (+) indicates a right correction; a minus sign (−) indicates a left correction. *b.* The fuze correction will be displayed to the nearest 0.1 second in the FUZE SETTING window. The sign of the correction will be displayed on the first Nixie tube in the window. A blank will indicate a plus

(G–7) and QE INPUT (G–8).

(3) Override the fuze type by using the procedure outlined for FUZE TYPE (B–6), if a time registration also was fired.

(4) Enable HI ANGLE (B–2) if a high-angle registration was fired.

(5) Override the charge by following the procedure for CHG (B–1).

(6) Depress matrix buttons H–8. (COMP REG). (Matrix window will light.)

★(7) Depress the SM key (Corrections are computed and displayed) puter for fuze time.

(8) Store the registration corrections for the charge used by typing the charge number on the keyboard and depressing the ENTER key. (KEYBOARD indicator light will remain on.)

(9) If it is desired to store the corrections for the nonregistering batteries, depress the appropriate battery button and repeat step in (8) above. Repeat this step for each battery desired.

(10) After the corrections have been stored for batteries desired, terminate the mode by depressing the decimal point key. (KEYBOARD indicator light will go out.)

2. The procedure for computing the corrections for a mean-point-of-impact registration is as follows:

a. Conduct of registration. The computer is used to compute correction; a 9 will indicate a minus.

c. Range correction will be displayed as range K (meters/1000) in the QUADRANT window. The sign of the correction will be displayed in the same manner as the sign of the fuze correction.

5. Current meteorological data, projectile weight, powder temperature, and muzzle velocity for the charge concerned should be entered into the computer before the registration corrections are computed. The corrections displayed by the computer will be functions of any parameters left at standard, inaccuracies of measurement, the age of the met data, and the other materiel parameters entered. Registration corrections will be associated with the battery, charge, and trajectory. They will not be projectile associated; therefore, they will be applied for all types of shells. Registration corrections determined for the 8-inch AE shell by firing HES shell should be dismissed by using function H–7 (ZERO CORR) before other types of shells are fired; conversely, registration corrections determined for HE should be dismissed before data are calculated for the HES or AE rounds.

6. The computer may be used to assist in determining the following data for a precision registration:

a. Angle T. Upon entry of the registration point coordinates and altitude, use the REPORT POLAR (D–7) function to determine the azimuth and range from the battery to the registration point. Manually compare the battery-registration point azimuth with the observer-registration point azimuth to determine the angle T.

b. Factor S. Use the range displayed by the computer and the angle T determined in a above to enter the S/2 table on DA Form 6–12 and determine the value of S/2.

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
			the firing data, orient the target base, and compute the location of the mean point of impact. The steps are as follows: (1) Select the battery to which the corrections will apply by depressing the battery button. (2) Recall or enter the coordinates and altitude of the registration point by following the recall procedure for TGT STORE (A–4) or the entry procedure for TGT EAST (A–1), TGT NORTH (A–2), and TGT ALT (A–3). (3) Compute the orienting data by performing step 3 of the entry procedure for SURVEY (D–5). Observers will be oriented as outlined in FM 6–40. (4) Insure that fuze quick or shell HE has not been overridden and cause the computer to compute the firing data in normal manner. (5) Conduct the registration by following the procedure in FM 6–40. *b. Computation of registration corrections.* The computer is used to compute the registration corrections. (See remarks 3.) The procedure for computing registration corrections and applying them to subsequent computations is as follows: (1) Manually determine the		*c. Site.* Enter the registration point coordinates and altitude into the computer. (1) Cause the computer to compute the firing data in the normal manner. (2) Change the target altitude to the altitude of the battery. (3) Cause the computer to compute the firing data. (4) Subtract the QE determined in (3) above from the QE determined in (1) above. The difference will be site. (5) Reenter the correct target altitude for subsequent corrections.

average azimuth and the vertical angle from the observer base.

(2) Use the computer to compute the location of the mean point of impact by performing step 2 of the entry procedure for SURVEY (D-5).
The computation of the mean point of impact in this man-

Table 2–1. *Detailed Matrix Functions*—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
COMP REG	H–8 (Cont)		ner will cause it to be stored as the current target for the battery selected by depressing the battery button. If the mean point of impact has been determined by another method, enter its location by following the entry procedures for TGT EAST (A–1), TGT NORTH (A–2), and TGT ALT (A–3). (3) The remainder of the procedure is the same as that for precision registration. Perform the steps described in 1*b*(2) through 1*b*(10) above. 3. The procedure for computing the corrections for a high-burst registration is as follows: *a. Conduct of registration.* The computer is used to compute the firing data, orient the target base, and compute the location of the high burst. The steps are as follows: (1) Select the battery to which the corrections are to apply by depressing the battery button. (2) Recall or enter the coordinates and altitude of the registration point (adding the height of burst over the registration point to the altitude of the registration point) by following the recall procedures for TGT STORE (A–4) or the entry procedures for TGT EAST (A–1), TGT NORTH (A–2), and TGT ALT (A–3).		

Table 2–1. Detailed Matrix Functions—Continued

Input function	Matrix location	Btry	Entry procedure	Recall procedure	Remarks
COMP REG	H–8 (Cont)		(3) Compute the orienting data by performing step 3 of the entry procedure for SURVEY (D–5). Observers will be oriented as outlined in FM 6–40. (4) Select fuze time as outlined in entry procedures for FUZE TYPE (B–6). (5) Insure that shell HE has not been overridden. (6) Enter a correction of DOWN 20 by using the entry procedure for UP/DOWN (A–8). This correction will compensate for the automatic addition of 20/R by the computer for fuze time. (7) Cause the computer to compute the firing data in the normal manner. (8) Conduct the registration as outlined in FM 6–40. *b. Computation of registration corrections.* The registration corrections and the procedure for computing the registration corrections are identical to those presented for the mean-point-of-impact registration except that the high-burst point is used instead of the mean point of impact, and since fuze time will be fired, the remarks pertaining to the fuze correction in the steps described in 1*b*(2) and (3) above will apply.		

Section VI. COMPUTER OUTPUT AND COMPUTATIONAL SEQUENCE

2-23. Display Panel

a. The display panel (fig 2-8) is the primary output device for the cannon programs. It consists of 18 Nixie tube indicators, which provide a display of the numerical, sign, and designation information as the data are being entered through the keyboard and an output display of the problem solution. Error indication flags are also displayed if there is *no solution* to a problem.

b. The display panel is divided into six windows which display the following data:

(1) The first window, BATTERY, displays the letter A, B, C, D, or E, for the battery button depressed.

(2) The second window, SIGN, displays the algebraic sign (+ or −) for the numerical output or input. When latitude is entered, a plus sign indicates north latitude and a minus sign indicates south latitude.

(3) The third window, CHARGE, displays the powder charge selected or the optimum charge determined by the computer. Certain input data (such as the first digit in met entry) are displayed in this window before the ENTER key is depressed.

(4) The fourth window has five Nixies labeled DEFLECTION, AZIMUTH, and EASTING. The display depends on the matrix position selected and whether the information is an input or an output. When coordinates are being entered in sequence (easting, northing, altitude), the easting is displayed in this window and the northing and altitude are displayed in the two windows to the right. When information consisting of more than five digits, such as that used in the survey routines is entered or recalled, the display of information will be continued in the next window. Much of the information which is recalled separately is displayed in this window. The deflection is displayed as the result of trajectory computation and solution.

(5) The fifth window has five Nixies and is labeled FUZE SETTING, TIME OF FLIGHT, DISTANCE, and NORTHING. The information displayed depends on the matrix position selected and whether the information is an input or an output.

(6) The last window has five Nixies and is labeled QUADRANT, VERTICAL ANGLE, and ALTITUDE. Again, the information displayed depends on the matrix position selected and whether the information is an input or an output. In certain instances, a flag typed on the keyboard is initially displayed in the fourth window. Then, when the ENTER key is depressed, the flag is displayed in the sixth window during the keyboard entry of additional data.

2-24. No Solution Displays

a. When an input item is entered by an erroneous procedure or the information being entered is incorrect (i.e., a number too large for the computer), the NO SOLUTION indicator blinks and a number is displayed to identify the error. Table 2-2 describes the error identified by each number displayed and explains the corrective action for each error.

b. In the chronograph program a flashing ERROR light may indicate that the parameters entered are being used with an incorrect weapon. Check the battery button (1 or 2) to insure that the proper weapon is being used.

Table 2-2. No Solution Displays, Description of Errors, and Corrective Actions.

Display	Description of error	Corrective action
X . . . 0	Out of range for X charge	Enter the next higher charge.
. . . 1	Battery button changed during computations	Wait for COMPUTE indicator to go out before changing the battery button.
. . . 2	Improper shell-fuze combination, no height of burst entered, or projectile weight too great.	Recall the inputs to determine which error is indicated and reenter the corrected data.
. . . 3	Observer corrections entered without A-5 (OT DIR) entry.	Enter OT direction, and reenter corrections.
. . . 4	Improper white bag charge.	Enter correct data.
. . . 5	Erroneous data or flag entered in survey problem. Procedural error.	Recall the inputs to determine which data were not entered or were entered in error. Enter correct data.
. . . 6	No target entered	Enter target data.
. . . 7	No charge entered before function H-8 (COMP REG) was used.	Enter charge used in registration.

Table 2-2. No Solution Displays, Description of Errors, and Corrective Actions—Continued

Display	Description of error	Corrective action
X . . . 8	Target before the peak of the trajectory. Out of range for X charge.	Enter the next lower charge, or use high-angle fire.
. . . 9	Error in entry of decimal values	Reenter data with no more than two digits after decimal point.
. . .10	Attempt to store negative altitude.	Store only positive altitude values.
. . .24	SEND or COMPUTE button erroneously depressed in improper mode.	Use correct mode.
Gun data and NSL	Target or intended impact point is in a no-fire area, or maximum elevation is exceeded.	Use recall procedure for F-4 (NO FIRE AREA STORE).

2-25. How the FADAC Computes the Ballistic Trajectory

a. The M18 computer is programmed to solve the ballistic trajectory by integrating the equations of motion for a projectile in flight. This technique is the same as the computational technique used in making a firing table except that, in the computer solution, the trajectory is computed on the basis of actual weather, weapon, and ammunition data instead of hypothetical standard conditions. The computer uses the nonstandard information entered by the operator, however, if a specific element is unknown and no information is entered for that element, the computer will use the standard value for the element.

b. Figures 2-15, 2-16, and 2-17 graphically illustrate the steps used in the cannon program to solve the ballistic equations of motion.

(1) The range and azimuth to the target are mathematically computed from the battery and target coordinates entered.

(2) The computer then selects the optimum charge or uses the ordered charge and determines a trial quadrant elevation.

(3) Using the trial quadrant elevation, the computer simulates the trajectory by integrating the equations of motion for a projectile in flight with gravity, weather, aerodynamic drag, and other forces acting on the projectile. The battery location, the muzzle velocity, and a trial quadrant elevation are used as the initial conditions for the first integration.

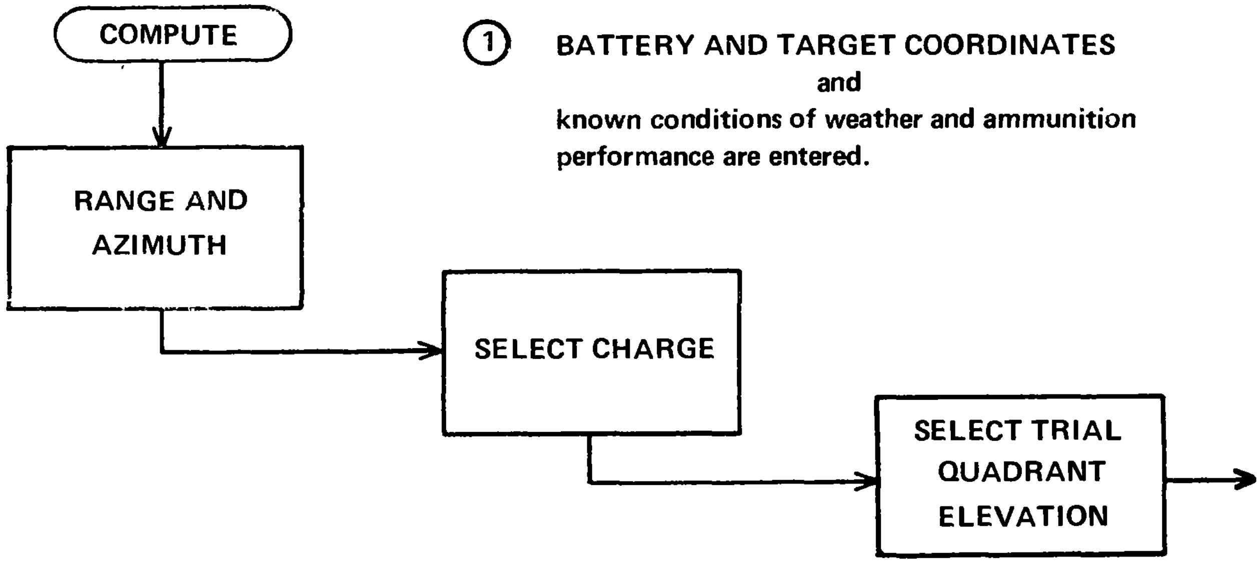
(4) After the projectile has traveled the first fraction of a second and its range (X) and height (Y) are known, the computer solves the next integration. Acceleration is integrated to find velocity, and velocity is further integrated to determine a new location, acceleration, and velocity for continuing the integration. At each step, the location of the projectile is compared with the target altitude.

(5) When the computed altitude of the projectile is below the altitude of the target, the integration stops and a miss distance is computed from the initial range. If the miss distance is less than 10 meters, final corrections are applied for the miss distance and gun data are displayed. The lateral displacement resulting from drift, rotation of the earth, registration deflection correction, and crosswind are applied during each step of the integration. If the miss distance is greater than 10 meters, a correction for the miss distance is applied to the initial trial quadrant elevation, and the trajectory computations are repeated.

c. The computer uses high-explosive (HE) shell, fuze quick (Q), unless the operator enters numbers designating a specific shell and a specific fuze. The computer automatically uses the best propellant charge unless a specific charge is designated by the operator.

2-26. No-Fire Area Subroutine

a. The cannon program provides a safety subroutine that permits areas or points to be precluded from friendly artillery fires. Each area is input as a circle. Input data consists of the coordinates of the center of the circle and a safe radius. Thirty-nine such areas may be stored in memory. When the M18 computes firing data, it first determines the direction and range to the target or intended burst point. If the intended burst point falls inside any one of the no-fire areas stored in memory, the NO SOLUTION indicator will blink; however, the COMPUTE indicator will remain on and the gun data will be displayed. The blinking light warns the operator that the displayed firing data will result in rounds falling in one of the no-fire areas stored in memory. The computer checks each area sequentially, beginning with area number 1. The operator may identify which area is causing the



(1) BATTERY AND TARGET COORDINATES
and
known conditions of weather and ammunition performance are entered.

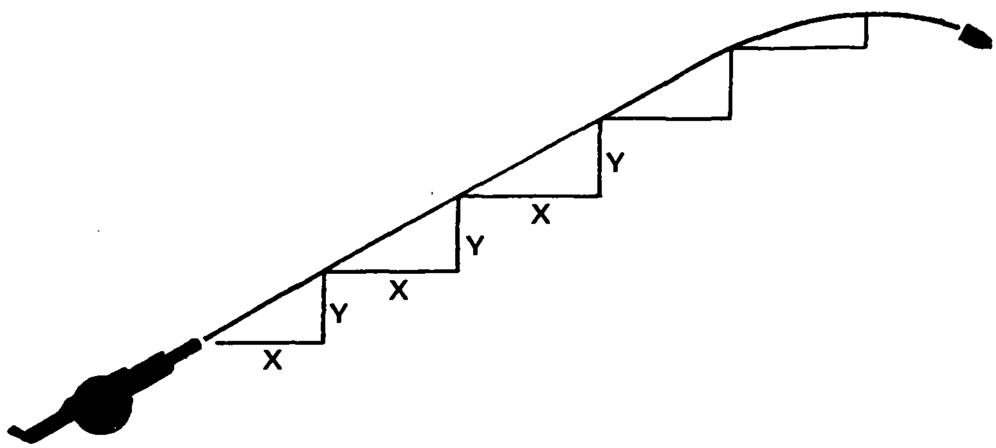
(2) FADAC COMPUTES RANGE AND AZIMUTH
and
selects the optimum charge and a trial quadrant elevation.

Figure 2–15. Steps 1 and 2 of computation.

(3) THEN COMPUTES (X) RANGE and (Y) HEIGHT for the first fraction of a second, using the equations of motion:

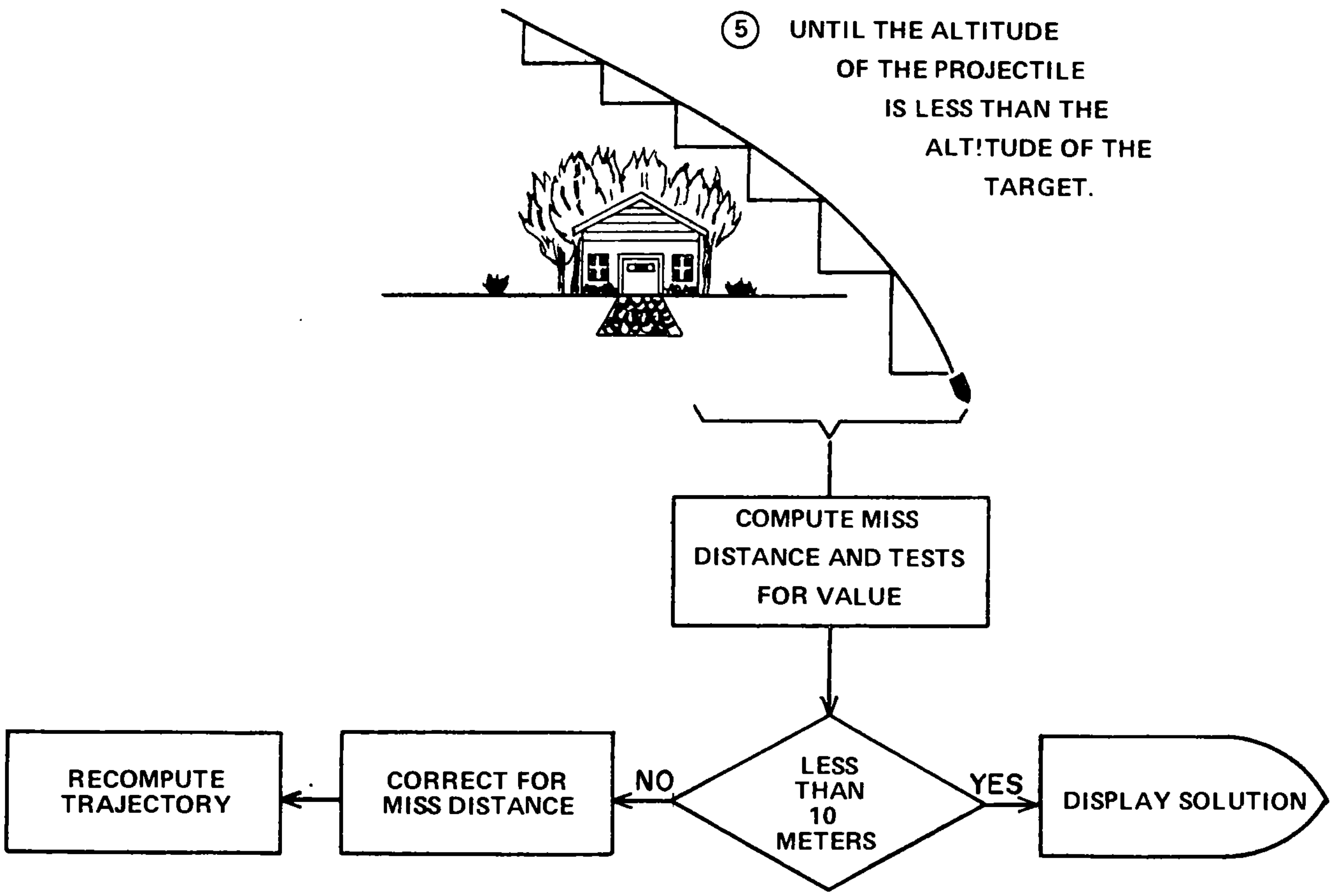
X = f (Cos $\measuredangle$ elevation, muzzle velocity, weight, drag, weather, time)

Y = f (Sin $\measuredangle$ elevation, muzzle velocity, drag, weather, gravity, time)



(4) THEN, with a new velocity, $\measuredangle$, and considering weather, etc., at this time, compute X and Y for another time interval, and so on.

★*Figure 2–16. Steps 3 and 4 of computation.*



★*Figure 2-17. Step 5 of computation.*

NO SOLUTION indicator to blink by using matrix function F-4 (NO FIRE AREA STORE). (See table 2-1). The number of the area will be displayed. During an observer adjust-fire mission, when the observer adjusts rounds into a precluded area, the NO SOLUTION indicator will blink just as it does when the initial target location is in a no-fire area.

b. The safe radius of an area can be determined by using a map or photomap and a scale to measure the size of the area and then adding a buffer distance to compensate for the width or depth of the battery, the distance from the point of impact to which shell fragments will be effective, and dispersion. A buffer distance of 3 probable errors for range, plus one-half the width of the battery front, plus 100 meters (for HE shell fragmentation) is added to the measured radius to attain a high assurance (98 percent) that rounds will not fall in the area. All charges are considered, and the largest PE_r, indicated in the tabular firing table for the range to the center of the preclusion area is used.

c. The safety warning (*a* above) is valid only when *all* gunnery parameters entered in the M18 are accurate. For example, if the met data being used are in error, or if poor registration corrections are in the computer, or if the altitude of the target is incorrect, errors will occur in the gun data; consequently, the rounds might impact in a no-fire area. This safety feature is only as good as the data used in the computer. If the accuracy of the corrections is doubtful, the S3 should consider using a larger buffer distance in calculating the safe radius.

d. When the no-fire area data stored in memory for specific firing positions are no longer valid, the data must be deleted. No-fire area data inadvertently left in memory when a new firing position is occupied may cause the computer to erroneously indicate a no-fire area. The operator should follow the procedure in *e* below to delete the entire no-fire area list, or he should delete specific areas by using the following procedure:

(1) Depress matrix buttons F–1 (NO FIRE AREA EAST).

(2) Depress the SM key.

(3) On the keyboard, type 00000,

(4) Depress the ENTER key.

(5) Depress matrix buttons F–2 (NO FIRE AREA NORTH).

(6) Depress the SM key.

(7) On the keyboard, type 00000.

(8) Depress the ENTER key.

(9) Depress matrix buttons F–3 (NO FIRE AREA RADIUS).

(10) Depress the SM key.

(11) On the keyboard, type 00000.

(12) Depress the ENTER key.

(13) Depress matrix buttons F–4 (NO FIRE AREA STORE).

(14) Depress the SM key.

(15) On the keyboard, type 1 (to delete area *1*).

(16) Depress the ENTER key.

(17) Depress the SM key.

(18) On the keyboard, type 2 (to delete area 2).

(19) Depress the ENTER key.

e. To delete the entire list, 39 areas, us e the following procedure:

(1) Depress matrix buttons F–4 (NO FIRE AREA STORE).

(2) Depress the SM key.

(3) On the keyboard depress the decimal point key (.).

(4) Depress the decimal point key (.) a second time.

(5) Depress the ENTER key. The COMPUTE indicator will light momentarily and the no-fire area list will be deleted.

CHAPTER 3

COMPUTER APPLICATION, CANNON ARTILLERY

Section I. GENERAL

3-1. Purpose

This chapter describes the application of the M18 computer in—

a. Normal fire direction center operations.
b. Special situations.
c. Registrations.

3-2. Fire Direction Center Operations

A suggested sequence of events and distribution of duties for battalion fire direction center personnel are presented in table 3-1. The detailed requirements for the computation and transmission of firing data for routine adjust-fire and fire-for-effect missions are described in *a* and *b* below.

a. Adjust-Fire Mission. When an adjust-fire mission is received, the vertical control operator (VCO) plots the target on a battle map or a firing chart. The S3 checks the target location and issues the fire order.

(1) The computer operator enters the target data and the appropriate mission overrides requested by the forward observer or announced in the fire order. The operator computes the firing data for the batteries to fire, computes the polar replot to check the VCO's orienting data with the data input, enters the observer corrections, announces the new firing data when required, and stores the target when directed.

(2) The adjusting battery computer/recorder receives the orienting data from the VCO and the firing data from the computer operator and announces the fire commands to the adjusting battery.

(3) The VCO announces the target altitude to the computer operator and the orienting data to the computer/recorders. The VCO computes the site for each battery. He assists in computing the data for replot and plots the target on his firing chart, when directed.

(4) The computer/recorders for the nonadjusting batteries receive the orienting data from the VCO and the initial firing data from the computer operator. They transmit the mission to their respective batteries with the command DO NOT LOAD.

b. Fire-for-Effect Mission. The fire-for-effect mission is processed similarly to the adjust-fire mission.

(1) When the fires of a battalion of mixed calibers are being massed, the computer operator first computes the data for the slower firing (larger caliber) weapons to expedite fire for effect.

(2) The computer operator must precede all announced firing data with the designation of the battery to fire just as he does in the fire-for-effect phase of an adjust-fire mission.

c. Battery Operation. A suggested sequence of events and distribution of duties for battery fire direction personnel operating a battery FDC are shown in table 3-2.

Table 3–1. Duties of Battalion Fire Direction Center Personnel (During Firing)

Sequence	S3	Chief computer	Computer operator	Vertical control operator	Computer/ recorder	Radiotelephone operator	Switchboard operator
1	Supervises activities of section personnel.	Supervises activities of section personnel, insuring that all	----------		Records fire mission data on computer's record.	Receives and records fire mission	Operates switchboard.
2	----------	M18 input is double-checked as it is entered.	Enters target data.	Plots target on grid sheet or map.	----------	----------	Performs other duties as directed.
3	Issues fire order.						
4	----------	----------	Enters target altitude announced by VCO.	Determines and announces target altitude and orienting data for batteries to fire.	Sends orienting data and preliminary commands to batteries.	Sends message to observer.	
5	----------	----------	Enters required mission overrides.				
6	----------	----------	Computes and announces firing data. Checks VCO orienting data.	Computes site and prepares for manual backup, as directed.	Sends remaining fire commands to batteries.		
7	----------	----------	----------	----------	Receives SHOT from the batteries.	Transmits SHOT to the Observer.	
8	----------	----------	Enters OT direction, if required. Enters observer corrections and announces firing data.	----------	Sends subsequent commands to the batteries.		
9	Orders replot of target, as required.	----------	Assists VCO in target replot.	Assists computer operator in target replot.	Records data for replot on computer's record.		
10	----------	----------	Stores target, as required.	Updates firing chart, as required.			

Table 3-2. Duties of Battery Fire Direction Center Personnel

Sequence	Fire direction officer	Computer operator	Vertical control operator	Computer/recorder	Radiotelephone operator
1	Supervises activities of section personnel, insuring that all M18 input is double-checked as it is entered.	----------	----------	Records fire mission data on computer's record.	Receives and records fire mission.
2	----------	Enters target data.	Plots target on grid sheet or map.		
3	Issues fire order.				
4	----------	Enters target altitude announced by VCO.	Determines and announces target altitude and orienting data.	Sends orienting data and preliminary commands to the battery.	Sends message to observer.
5	----------	Enters required mission overrides.	Computes site and prepares for manual backup, as directed.		
6	----------	Computes and announces firing data. Checks VCO orienting data.	----------	Sends remaining fire commands to the battery.	
7	----------	----------	----------	Receives SHOT from the battery.	Transmits SHOT to the observer.
8	----------	Enters OT direction, if required. Enters observer corrections and announces firing data.	----------	Sends subsequent commands to the battery.	
9	Orders replot of target as required.	Assists VCO in target replot.	Assists computer operator in target replot	Records data for replot on computer's record.	
10	----------	Stores target, as required.	Updates firing chart, as required.		

Section II. COMPUTER PROCEDURES FOR SPECIAL SITUATIONS

3-3. Multiple Fire Missions

The FADAC may be used to compute firing data to mass the fires of five separate fire units. Targets can be transferred from one battery to another by using matrix function B-8 (MASS FIRES). Data for a mission can be temporarily stored in memory while a more lucrative target is attacked; then the stored data can be reentered by using matrix function D-6 (TEMP MSN STORE). These capabilities provide the S3 with considerable flexibility in processing multiple fire missions.

3-4. Polar Coordinate Missions

a. When an observer locates a target by polar coordinates, he should report the angle of the vertical interval, if possible. Also, he should indicate whether the range is horizontal range or slant range, unless it is obvious. If the range is measured by mechanical means, such as laser or radar, it is considered to be a slant range. The range measured from a map or estimated is considered to be a horizontal range. Range reported by a forward observer equipped with laser may be either horizontal range or slant range, depending on the method used by the observer to measure the range. The vertical interval is computed by the FADAC.

b. The vertical interval may be used when the observer does not have a means of measuring a vertical angle. However, this procedure is the least preferred method. The procedure for entering a vertical interval is as follows: first a vertical angle of +0 is entered by using matrix function C-7 (OBS VERT ANGLE); then the vertical interval is entered into the FADAC with matrix function A-8 (UP/DOWN). When the target location is computed by using matrix function C-8 (POLAR PLOT MSN), the target altitude will appear to be in error; however, this altitude will actually be more accurate than if it were calculated manually by simple trigonometry because the FADAC applies the curvature of the earth and determines a more accurate altitude.

c. Radar locations may be stored in the FADAC as observer locations. This permits fast, accurate fire-for-effect target location calculations using the POLAR PLOT MSN (C-8) function.

3-5. Replotting Targets

a. The computer is capable of replotting targets. When the replot polar function is used, the azimuth, distance, and vertical angle from the battery to the target will be displayed, and when the replot rectangular function is used, the coordinates and altitude of the point where the computer trajectory passes through the target altitude will be displayed. The range displayed for the replot polar function will be the firing table range for the elevation required to reach the target. Therefore, it will not be accurate if registration corrections (range K other than zero) are being used. Table 3-3 presents the steps performed by the computer operator and the vertical control operator to determine the target replot data.

b. The accuracy of the target coordinates located by replot after an adjust-fire mission is dependent on the accuracy of the input data used by FADAC to compute "should hit" data. The accuracy of survey, met, muzzle velocity, powder temperature, projectile weight, and latitude input data affects the replot accuracy. Therefore, if one or more of these parameters are not known and standard values are used when the mission is fired, replot coordinates will be of limited value. The same is true of the manual solution. Whenever met, survey, or any other ballistic parameter is updated in the FADAC, shifting from a replotted target that has been stored or attempting to compute fire-for-effect gun data for the target may produce poor results unless the target locations are updated as discussed below:

(1) *Situation 1.* The survey of the position area is incomplete and therefore only approximate coordinates for the battery center have been entered in the FADAC, and targets have been fired, replotted, and stored in memory. All other ballistic inputs, including current met, have been determined and entered.

(2) *Solution to situation 1.* When accurate survey data become available, target locations are updated as follows:

(*a*) During firing, record the fire-for-effect gun data (deflection, time, quadrant, charge, fuze, shell type) for each mission and use function D-7 (REPLOT POLAR) to determine the azimuth, range, and vertical angle. Also record these data.

(*b*) Update the battery location and also enter the battery location as an observer location by using matrix functions C-1, C-2, and C-3. Input the previously determined azimuth, range, and vertical angle to the target by using matrix functions C-4, C-5, and C-7.

Table 3-3. Duties of Fire Direction Center Personnel in the Determination of Replot Data

Sequence	S3	Chief Computer	Computer operator	Vertical control operator	Computer/recorder
1	Supervises activities of section personnel.	Checks and supervises preparation of replot data.			
2			Causes FADAC to display initial replot location.		
3			Announces target coordinates to VCO.		
4				Plots target on map and announces altitude to computer operator.	
5			Enters target altitude announced by VCO.		
6			The computer operator and the VCO repeat the duties in sequences 2, 3, 4, and 5 until the target altitude displayed by the FADAC and the target altitude determined by the VCO agree within 1 meter. The last altitude announced is entered into FADAC.		
7	Directs the computer operator to store the target, if desired.				Records data for replot on computer's record.
8			Stores target in FADAC, as directed by the S3.	Plots target on the firing chart, as directed by the S3.	

(*c*) Use matrix function C-8 (POLAR PLOT MSN) to determine the approximate location of the target and, after insuring that all appropriate mission overrides previously used have been input, depress the COMPUTE button to determine gun data.

(*d*) Use matrix function B-4 (GT LINE ADJ) and apply corrections through matrix functions A-6 (RIGHT/LEFT) and A-7 (ADD/DROP) to make the "should hit" data computed by the FADAC agree with the "did hit" data. Bracketing techniques are recommended.

(*e*) Update the target coordinates by using the replot procedures outlined in table 3-3.

(*f*) This technique will be valid only if the FADAC inputs being used were valid at the time the mission was fired.

(3) *Situation 2.* Targets have been replotted and stored by using standard muzzle velocity and standard met data for the computer solutions. Currently, all other ballistic parameters (survey, powder temperature, projectile weight, and latitude) that were used are still valid, and the muzzle velocity and met data that were valid when the missions were fired have been determined and entered.

(4) *Solution to situation 2.* Target coordinates are updated as follows:

(*a*) Input the available data. Target replot data must always be based upon the most accurate input data available for the time the "did hit" data were valid.

(*b*) Recall the specific target and input all applicable overrides that were used to fire the mission.

(*c*) Use matrix functions G-6, G-7, and G-8 and input the "did hit" data as if these were the adjusted data for a registration.

(*d*) Use matrix function H-8 (COMP REG) to compute and display the corrections that normally would be registration corrections.

(*e*) Manually record these corrections but *do not* apply them. After corrections have been displayed and noted, depress the decimal point (.) key or the RESET button.

(*f*) Use matrix function D-7 (REPLOT POLAR) to determine the range to the target.

(*g*) Convert the deflection correction, determined in (*d*) above, from mils to meters (W = Rg x $\cancel{m}$).

(*h*) Convert the range K, determined in (*d*) above, to a total correction (K x Rg/1000 = total correction).

(*i*) Enable B-4 (GT LINE ADJ) and enter the deflection correction (determined in (*g*) above) through matrix position A-6 and the range correction (determined in (*h*) above) through matrix position A-7.

(*j*) Depress the COMPUTE button to determine new "should hit" data. Compare these data with the "did hit" data.

(*k*) Using functions A-6 and A-7, continue to make adjustments until the computed gun data agree with the "did hit" data. When they agree, determine the updated target coordinates by using matrix function D-8 (REPLOT RECT) as outlined in table 2-1.

3-6. Computations for Illuminating Shell

With the current cannon program, the M18 will automatically compute firing data for illuminating shell and provide the correct heights of burst for the M314 and M485 shells. Range and deflection spreads should be computed manually or with the FADAC as follows:

a. The deflection spread is computed by entering shifts of 400 meters left and 400 meters right from the center of the burst pattern of the M314 shell. In the manual solution, this shift is from the gun-target line for simplicity. With the FADAC, the deflection spread computation is made on the observer-target line, since the observer direction must be entered for subsequent corrections.

b. The range spread is computed by entering range shifts of plus 400 meters and minus 400 meters from the center of the burst pattern for the M314 shell. The range spread computation is made on the observer-target line.

c. The computer operator must shift back to the center of the burst pattern before entering the next observer correction.

d. The lateral spread and the range spread with the M485 shell should be 500 meters from the center of the burst pattern.

3-7. Battery Operations

When a battery operating independently has a requirement to fire in all directions from its position, a special procedure will simplify the computation of firing data. The following setup procedure is suggested:

a. Associate each platoon with a battery button; i.e., use the A button for the right platoon, use the B button for the center platoon, and use the C button for the left platoon.

b. If the position is organized so that one location is sufficient for battery fires, associate the D battery button with the battery center coordinates.

c. Associate the base piece with the E battery button when registrations are necessary.

d. Either function B-8 (MASS FIRE) or the D battery button can be used to cause the FADAC to compute simultaneous missions for the three platoons and mass their fires.

★3-8. Using the No-Fire Area Subroutine To Protect a Moving Patrol

The no-fire area subroutine can be used to protect a moving patrol. A series of overlapping circular no-fire areas are superimposed over the route selected for the patrol. The maximum distance that the patrol may deviate laterally from the designated route is used as the radius in computing the safe radius (para 2-26) of each circle. Ordinarily, the safe radius of only one circle must be calculated. These no-fire areas may be cancelled on call from the patrol leader or on a prearranged time schedule. As each no-fire area is cancelled, it must be deleted from the computer memory (para 2-26*d*).

Given: A night patrol intends to follow route ABC for a distance of approximately 1,800 meters. The route is sketched on a 1:50,000 map as shown in figure 3-1. The patrol does not intend to deviate laterally from this route by more than 200 meters. The weapons employed are 155-mm howitzer M109, and the battery front is 60 meters.

Solution:

a. The artillery fire direction center measures the chart range to the most distant point on the patrol route. This range is 8,250 meters. The following data are extracted from tabular firing table 155-AH-2: Charge 7 PE_r = 24.

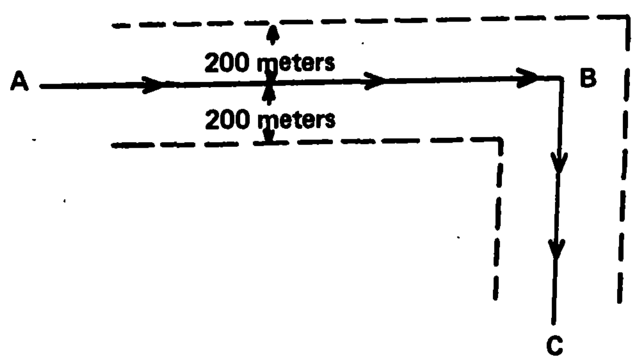
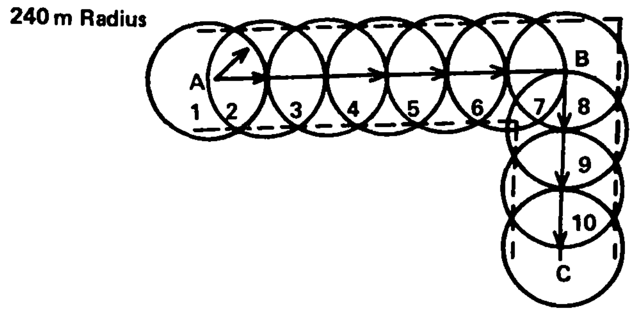


Figure 3-1. Route sketch.



★*Figure 3-2. Superimposed no-fire areas.*

b. The maximum lateral deviation (200 meters) is multiplied by 1.2 to obtain the radius of the circles to be superimposed over the route (fig 3-2). An initial circle with a radius of 240 meters is established, with the center of the circle at point A. Successive circles, with the center of each circle on the circumference of the preceding circle, are established along the route to the most distant point on the route. The coordinates of the center of each circle are determined graphically or, if time permits, are computed by using the traverse survey subroutine. Computational data consist of the azimuth of the patrol route and the distance to the center of each circle; zero vertical angles are used. The coordinates are then entered as centers of successive no-fire areas, starting with the first circle at point A.

c. A buffer distance of 4 PE_r, plus one-half the width of the battery front, plus 100 meters is added to the radius and the sum is entered as the safe radius for each no-fire area.

Radius	= 240 (200 x 1.2)
+ 4 PE_r	= 96 (24 x 4)
+ One-half the width of battery front	= 30
+ Fragmentation distance	= 100
Safe radius	= 466

★*d.* As the patrol progresses along the route, the artillery fire direction center is notified when no-fire areas are cancelled. In the event that more than 39 no-fire areas are required, new areas are entered into the computer memory when the cancellation of old areas leaves memory space available.

Section III. REGISTRATIONS

3–9. General

★*a*. When the input data are less accurate than the data required for predicted fire, a registration is necessary. Most often the missing input is the specific muzzle velocity determined for the lot of ammunition being used. The M36 chronograph should be used to determine muzzle velocity data whenever these data are unknown. See paragraph 3–12.

b. When the FADAC is used for registration computations, all known meteorological, weapon, survey, and ammunition data should be entered in the computer before the registration is begun. The registration corrections displayed by the computer will be the residual corrections between the adjusted data and the data computed with the input parameters entered. Therefore, the size of the registration corrections may be used as an indication of the accuracy of the input data (para 2–17*c*(9)).

c. When valid meteorological, survey, and ammunition data are entered before registration, the FADAC can determine an improved muzzle velocity for the lot of ammunition fired as described in paragraph 2–17*c*(1)(*b*). This improved velocity should be used, since it incorporates the residual error as a muzzle velocity change. Each time a registration is conducted under these conditions, this residual error can be reduced by using the average of the old muzzle velocity and the new one.

3–10. Registration Procedures

a. The entry procedures for computing data in a precision registration, a mean-point-of-impact (MPI) registration, and a high-burst (HB) registration are outlined under the COMP REG (H–8) function in table 2–1.

b. The duties of the FDC personnel and the sequence of events in a precision or time registration are presented in table 3–4.

★*c*. The duties of the FDC personnel and the sequence of events in a high-burst or mean-point-of-impact registration are presented in table 3–5. In either type of registration, the FADAC is used to compute orienting data for the target base, initial firing data for the registering piece, and the location of the high burst or mean point of impact.

3–11. Determining and Updating GFT Settings

★*a*. FADAC *should* be used with care in determining any GFT setting data, since registration corrections computed by the FADAC are residual corrections (*c* below) and should not be used in the manual solution. GFT settings for use with graphical equipment must be determined by using the adjusted data and the *chart range* to the registration point. Chart range must be determined from the chart to be used. Deflection corrections also must be determined in a similar manner. (See FM 6–40.)

b. The procedures for using the FADAC to compute data in a precision, high-burst, or mean-point-of-impact registration are explained in detail in table 2–1 under the entry procedures for matrix function H–8 (COMP REG). The FADAC computes the registration correction for range as a variable range K in meters per thousand and applies this correction to the initially computed range to a target. Even though this correction is associated with a battery and a specific charge, when used as a range correction, it will be applied regardless of the type of projectile; therefore, it is advisable to reduce this range K to zero by adjusting the muzzle velocity as explained in paragraph 2–17*c*(10)(*b*). This technique will isolate the correction to the specific battery, charge, and type of projectile to which it applies. This technique is only valid, however, when meteorological data and the other ballistic parameters are known and input; otherwise, the range K correction should be used.

c. Whenever registration corrections are determined by manual computations, the value of the total correction is the difference between the standard firing table "should hit" data and the actual "did hit" data. However, when the computer is used, most of the ballistic parameters will be known and input before the registration corrections are computed. Therefore, corrections determined with the computer will reflect the difference between the computer's "should hit" data, determined by using the available known parameters, and the actual "did hit" data. If all parameters are known and input, then the registration corrections will reflect the total accumulative error of all parameters.

d. It is apparent that care must be used in updating a parameter in the computer whenever registration corrections are being used. If one or

Table 3-4. Duties of Fire Direction Center Personnel in A Precision or Time Registration

Sequence	S3	Chief Computer	Computer operator	Vertical control operator	Computer/recorder	Radiotelephone operator
1	Supervises activities of section personnel.	Checks and supervises preparation of registration data.				
2	Directs that registration be fired. Selects registration point and observer. Issues fire order.	----------	----------	----------	Enters data on computer's record. Sends preliminary fire commands to the battery.	Sends appropriate part of the fire order to the observer.
3	----------	----------	Enters registration point coordinates and altitude.	Plots registration point on grid sheet.		
4	----------	----------	Computes and announces firing data.	Computes site and prepares manual backup.	Transmits remaining commands to battery.	
5	----------	----------	Enters OT direction ---	----------	Receives SHOT from the battery.	Transmits SHOT to the observer.
6	----------	----------	Enters observer correction.	----------	Records observer corrections.	Receives corrections from the observer.
7	----------	----------	Perform duties in steps 4 through 6 until completion of impact registration.			
8	Directs that time registration be fired.	----------	----------	----------		Alerts observer for time registration.
9	----------	----------	Recalls registration point.			
10	----------	----------	Enters adjusted data and causes the FADAC to compute the registration corrections.			
11	Announces the batteries and charges for which registration corrections are to be stored.	----------	Stores corrections for batteries and charges in the FADAC as directed.			
12	----------	----------	Computes firing data to targets and checkpoints throughout zone of responsibility.	Assists computer/recorder in computing GFT settings.		

more ballistic parameters were unknown at the time of registration, these specific parameters must not subsequently be input while registration corrections are still in effect. Any known parameter, however, may be updated at any time, since in this case only the *change* in the ballistic condition will be used by the computer.

★*e*. With careful control of inputs, as discussed in *d* above, the FADAC can be used to determine an adjusted elevation for use in maintaining a current manual GFT setting. The following procedure is used.

(1) Recall the registration point.

(2) Reenter any overrides used in the registration and make sure that the MV and projectile weight entered are the same as those used in the registration.

(3) Depress the COMPUTE button.

(4) Record the updated adjusted deflection, time, and quadrant.

(5) Subtract the previously determined site from the quadrant to obtain the new adjusted elevation.

(6) Compute the new deflection correction manually.

3-12. Determining and Using Muzzle Velocity Data

★*a*. The accurate determination of muzzle velocity for a specific weapon, firing a specific projectile, charge, and lot of propellant is critical in any trajectory computation. The muzzle velocity developed by each of the most frequently used charge and propellant lot combinations should be measured with an M36 chronograph or be determined by one of the methods described in paragraph 2-17*c*(10)(*b*) and (*c*). Muzzle velocity can be measured with the M36 chronograph while a battery is engaged in harassing/interdicting missions to avoid the expenditure of ammunition solely for the purpose of determining muzzle velocity data. This ability to determine muzzle velocity gives the FADAC-equipped fire direction center the final item of data needed to fire without registration.

★*b*. A projectile's efficiency in traveling through atmosphere is dependent on the aerodynamic design of the projectile. The word "drag" is used in ballistics to describe air resistance. Two projectiles carrying different payloads (e.g., HE and WP) that have the same "drag function" will perform the same ballistically. If the two projectiles were of the same weight and if they left the tube at the same velocity, both projectiles would travel the same distance. Most of the projectiles for a specific caliber of weapon will perform in the same manner. For example, with the 155-mm howitzer, the HE projectile M107, WP projectile M110, smoke projectile M116, illuminating projectile M485, gas projectiles of the M121-series, and HE projectiles of the M449-series are all ballistically matched. It would appear that if the same propellant lot were used, the known MV for one shell could be directly applied to all the others. This is not the case. The effects of internal ballistics are shown in the tables of standard velocities in appendix C.

c. To use these known data, the difference in standard velocity (which is caused by differing internal ballistic effects) between shell types may be applied to the muzzle velocity of one type of shell measured with an M36 chronograph to determine the MV of the other shell types without firing the shells. The same lot of propellant must be used in computing these muzzle velocities, since MV is charge/lot/gun associated.

Example.

Given; Materiel consists of a 155-mm howitzer M109 and an M36 chronograph.

Situation: The M36 chronograph was used to measure the developed MV for Battery B during a night harassing mission. Shell HE M107, charge 6, propellant lot A, was used. The average muzzle velocity of six rounds was determined to be 458.2 meters per second. This velocity for shell HE, charge 6, when entered in the M18 computer, will automatically be applied when WP, smoke, or gas shell is fired. If the M485 illuminating shell or one of the M449-series of HE shells is fired, the difference between the standard MV of the shell to be fired and that of the HE shell M107 must be manually computed and applied to the measured MV of the M107 shell to determine the MV to be used.

Solution:

Shell type	*Standard MV Charge 6*	*Difference*	*FADAC input MV*
HE M107	463.0	–	458.2
Illum M485	472.0	+9.0	467.2
HE M449	460.5	−2.5	455.7
HE M449A1	462.4	−0.6	457.6
HE M449E1	457.9	−5.1	453.1

Situation continued: The M36 chronograph was used to measure the average muzzle velocity of a group of six rounds of shell HE M449A1, charge 5 (GB), of the same lot of propellant.

The average velocity was computed to be 352.8 meters per second. The muzzle velocity to be used for each of the other types of shells can be computed by determining the difference between the standard velocity of the shell to be fired and that of the HE shell M449A1 and applying the difference to the measured muzzle velocity of the M449A1.

Solution:

Shell type	*Standard MV Charge 5 (GB)*	*Difference*	*FADAC input MV*
HE M449A1	377.2	–	352.8
HE M449	376.9	−0.3	352.5
HE M449E1	374.4	−2.8	350.0
HE M107	378.0	+.8	353.6
Illum M485	388.0	+10.8	363.6

d. The M36 chronograph should be used continually to measure muzzle velocity of each lot of ammunition to be used in unobserved fires. The valid muzzle velocity input for shells can be determined as illustrated in the preceding example.

e. The accuracy of the firing data produced by FADAC without registration will depend primarily upon the validity of met, since all of the other parameters including muzzle velocity can be accurately measured. Whenever there is doubt as to the validity of met, check rounds should be fired or a registration should be conducted. When all parameters are known and input and a registration has been conducted, the range K computed by the M18 computer will most likely reflect the error in met.

3-13. Base Piece Displacement

When the base piece is displaced from the battery center, the coordinates and altitude of the base piece rather than the coordinates and altitude of the battery center are entered in the computer for the registration. The FADAC will automatically correct for the basic piece displacement in computing the registration corrections to be used.

3-14. Radar Registration

a. A radar may be used to determine the location of the center of a group of rounds fired in a high-burst registration. The FADAC can compute the location by entering the radar as an observer and using the POLAR PLOT MSN (C-8) function.

b. The radar can locate the high burst by either coordinates or polar data (observer slant distance, direction, and vertical angle); however, the S3 can more easily use polar data in checking for usable rounds. Six usable rounds are required. The mean distance, direction, and vertical angle of the six rounds must be computed manually and entered into the FADAC. After the location of the high burst has been computed, the gun data fired are input with matrix functions G-6, G-7, and G-8 (DF INPUT, TIME INPUT, AND QE INPUT). Registration corrections are computed in the normal manner by using matrix function H-8 (COMP REG).

Table 3-5. Duties of Fire Direction Center Personnel in High-Burst or Mean-Point-of-Impact Registration

Sequence	S3	Chief computer	Computer operator	Vertical control operator	Computer/recorder	Radiotelephone operator
1	Supervises activities of section personnel.	Checks and supervises preparation of registration data.				
2	Directs that registration be fired. Selects registration point. Issues fire order.					
3			Enters 01, 02, and registration point. Causes FADAC to compute orienting data for 01 and 02.	Plots 01, 02, and registration point.	Alerts battery to fire	Alerts observers at 01 and 02.
4			Announces 01 and 02 orienting data.	Manually checks 01 and 02 orienting data.	Transmits preliminary fire commands to the battery.	Transmits orienting data to 01 and 02.
★5			Causes FADAC to compute firing data. Announces firing data.		Transmits remaining fire commands to the battery.	
6	Coordinates firing with observers.				Receives SHOT from the battery.	Transmits SHOT to 01 and 02.
7			Recalls 01 and 02 locations in FADAC.		Records 01 and 02 data and computes mean directions and vertical angle.	Receives and announces data from 01 and 02.
8			Enters mean directions and vertical angle. Causes FADAC to compute HB or MPI location. Announces location.	Plots mean directions to HB or MPI. Checks location of MPI or HB with FADAC location.		
9			Enters the adjusted data and causes FADAC to compute registration corrections.			

Table 3–5. Duties of Fire Direction Center Personnel in High-Burst or Mean-Point-of-Impact Registration—Continued

Sequence	S3	Chief computer	Computer operator	Vertical control operator	Computer/recorder	Radiotelephone operator
10	Announces batteries and charges for which to store registration corrections.	----------	Stores corrections for batteries and charges, as directed.			
11	----------	----------	Computes firing data to targets and checkpoints throughout zone of responsibility.	Assists computer/recorder in computing GFT settings.		

Section IV. USE OF THE CHRONOGRAPH EXTRAPOLATION PROGRAM

3-15. General

a. The conversion of the projectile velocity measured and displayed by the radar chronograph M36 to developed velocity at the muzzle can be extrapolated by using the gun direction computer M18.

b. This automatic solution of the reduction of measured velocity is not restricted to those delay gate positions in the chronograph extrapolation tables contained in TM 9-1290-325-12/2. Any delay gate position used may be entered in matrix function D-2 and the computer will automatically solve the extrapolation problem and display the converted muzzle velocity.

3-16. Chronograph Program Matrix Functions

a. Matrix function D-1 (M36/CHRON) is used for input and control of the chronograph program.

b. Matrix functions D-2 (% DEN/DELAY), G-1 (MV), G-2 (POWD TEMP), G-3 (PROJ WEIGHT), G-8 (QE INPUT), B-1 (CHG), B-3 (WHITE CHG 3, 4, 5), and B-5 (PROJ TYPE) are used to enter all other data pertinent to the chronograph extrapolation program. Details on the use of these matrix functions are presented in table 2-1.

3-17. Setup for Chronograph Program

a. The chronograph program is a separate part of the cannon program and cannot be used until the setup procedure described in *b* below has been accomplished. When the chronograph program has been set up for use, the cannon program cannot be used until the chronograph program is dismissed.

b. The following operator actions will set up the chronograph program:

(1) Depress the appropriate weapon button (1 or 2) that applies to the caliber or type of weapon, the same as used to set up the batteries for the ballistic program.

(2) Depress matrix buttons D-1 (M36/CHRON).

(3) Depress the SM key.

(4) On the keyboard, type 0.

3-18. Example of Use of the Chronograph Extrapolation Program

a. Situation. A cannon program for the 155-mm howitzer M109 has been loaded into the FADAC. Program test 1 has been made, and the following correct program identification appeared on the display panel: 1 00000 00041 05155. Battery setup has been accomplished by depressing weapon button 2.

b. Given. The following data has been reported.

(1) Weapon: 155-mm howitzer M109.

(2) Readout velocity from M36 chronograph for the first round: 380.9 meters per second.

(3) Powder temperature: +20° F.

(4) Projectile weight: 93.9 pounds.

(5) Quadrant elevation: 600 mils.

(6) Charge: 5.

(7) Projectile: HE (flag 1).

(8) Delay gate: 1.

(9) Density: 107.5 percent.

c. Solution: Operator actions are as follows:

(1) Insure that weapon button 2 has been depressed.

(2) Depress matrix buttons D-1 (M36/CHRON).

(3) Depress the SM key.

(4) On the keyboard, type 0.

(5) Depress matrix buttons G-1 (MV).

(6) Depress the SM key.

(7) On the keyboard, type 380.9; check the Nixie display and then depress the ENTER key.

(8) Depress matrix buttons G-2 (POWD TEMP).

(9) Depress the SM key.

(10) On the keyboard, type +20; check the Nixie display and then depress the ENTER key.

(11) Depress matrix buttons G-3 (PROJ WEIGHT).

(12) Depress the SM key.

(13) On the keyboard type 1, depress the ENTER key, and then type 93.9; check the Nixie display and then depress the ENTER key.

(14) Depress matrix buttons G-8 (QE INPUT).

(15) Depress the SM key.

(16) On the keyboard, type 600; check the Nixie display and then depress the ENTER key.

(17) Depress matrix buttons B-1 (CHG).

(18) Depress the SM key.

(19) On the keyboard, type 5; check the Nixie display and then depress the ENTER key.

(20) Depress matrix buttons B-5 (PROJ TYPE).

(21) Depress the SM key.

(22) On the keyboard, type 1; check the Nixie display and then depress the ENTER key.

(23) Depress matrix buttons D-2 (% DEN/DELAY).

(24) Depress the SM key.

(25) On the keyboard, type 1 depress the ENTER key, and then type 107.5; check the Nixie display and then depress the ENTER key.

(26) Depress the SM key.

(27) On the keyboard, type 2, depress the ENTER key, and then type 1; check the Nixie display and then depress the ENTER key.

(28) Depress the SEND button. The following solution will be displayed:

386.4 -------------------	155
(Extrapolated muzzle velocity)	(Weapon designation)

3-19. Average Muzzle Velocity

The muzzle velocity data for each of six rounds are determined as illustrated in the example in paragraph 3-18. However, as long as the input parameters do not change, they need not be re-entered. Subsequent rounds will normally require changes only in the entry of readout MV through matrix position G-1 and the fired QE through matrix position G-8. The arithmetic mean of the six rounds is then computed manually to determine the average developed muzzle velocity.

3-20. Return to the Cannon Program

Returning to the cannon ballistic program is accomplished by performing the following actions:

a. Depress matrix buttons D-1 (M36/CHRON).

b. Depress the SM key.

c. On the keyboard, type 9.

CHAPTER 4

COMMON MISTAKES AND MALPRACTICES

4-1. General

Inaccuracies in FADAC computations and lack of faith in the reliability of FADAC are too often the result of recurring mistakes and malpractices. A mistake is an unintentional error in action or perception made in the execution of a correct procedure. A mistake usually indicates carelessness or lack of concentration and can be detected only by a positive check or very close supervision. A malpractice is a procedural error and usually indicates inadequate or improper training. The best preventive measure to avoid mistakes and malpractices is the formation of proper habits in training. Personnel responsible for training FADAC operators must insist on exactness and allow no deviation from correct procedures. A further measure to prevent errors is to establish proper supervisory procedures for the fire direction officer and chief computer to insure that all errors are detected and corrected before firing.

4-2. FADAC Operator Procedures

★*a. Common Mistakes.* Some of the common mistakes made by FADAC operators in determining firing data with the FADAC are as follows:

(1) *Failure to end the mission.* The end-of-mission function erases the override data (charge, projectile, fuze, etc.) associated with a particular mission. If this function is not used, the overrides will remain in effect for subsequent missions.

(2) *Incorrect entry of observer corrections.* If an error in observer corrections is detected before the computer is placed in the compute mode, the operator can correct the error by entering the correct data. If the error is detected after the computer has been placed in the compute mode, the operator must enter and compute an equal and opposite shift before entering the desired observer's shift.

(3) *Incorrect computation of registration corrections.*

(*a*) Since the FADAC can compute only the adjustment phase of a precision registration, manual computations are required for completing the fire-for-effect (FFE) phase. Before entering the adjusted data into the computer, the operator must use the end-of-mission function to clear the FFE data from the computer. He must then enter or recall the actual location of the registration point before entering the adjusted data. This will insure that registration corrections based on a comparison of "should hit" data to "did hit" data are correctly computed.

(*b*) If a meteorological message is *not* available when registration corrections are computed, the corrections must subsequently be recomputed when a met is received. However, the met message *must* be valid for the time the registration was fired.

(4) *Failure to set up the desired caliber.* The setup function is used to associate the program information for a specific caliber and type of weapon with selected batteries. When this function is used, all constants for a desired caliber are set to standard. This function must be used whenever the FADAC is reprogrammed or whenever different calibers are associated with the battery buttons.

(5) *Failure to cancel the gun-target line adjust function.* The gun-target (GT) line adjust function is used to indicate to the FADAC that all observer corrections will be made with respect to the gun-target line. Should the observer desire to change to a given direction, the GT line adjust function must be cancelled. If the operator does not cancel this function before entering a new observer-target direction, the FADAC will continue to use the GT line even after the new observer-target direction has been entered.

(6) *Failure to detect a change in charge.* If the operator does not specify a certain charge to be used in computations, the FADAC will select the optimum charge for the range in consideration. If the observer's adjustment involves a large range change, the optimum charge determined by the FADAC may change during the mission. The operator must be especially alert to avoid

firing the wrong charge when this situation occurs. A procedure which the operator can use is to override the charge before computing the observer's corrections. The FADAC would then use the charge selected for the initial firing data.

(7) *Failure to properly apply registration corrections.* If all ballistic parameters have been entered into FADAC before a registration, the computed corrections will reflect the accumulative errors of the existing input parameters. Most of these errors normally result from the use of meteorological conditions in the FADAC which differ from the actual conditions that existed at the time of the registration. To minimize the effect of these errors, this residual should be reduced to an adjusted muzzle velocity as described in paragraph 2-17. This adjusted MV should be used instead of a range K correction.

★*b. Malpractices.* Significant malpractices which detract from the proficiency of a fire direction center using the FADAC are as follows:

(1) *Failure to periodically check input data.* The variable ballistic parameters which are entered by the FADAC operator (muzzle velocity, projectile weight, propellant temperature, etc.) as well as the battery and target information stored in the computer should be recalled whenever there is a doubt as to what value is entered. As a minimum, this check of information stored in the computer should be performed whenever the operator is changed. This procedure will insure that the operator is always aware of the information used in computations. It will also serve as an additional check of stored information.

(2) *Failure to check the data displayed on the Nixie panel.* This error occurs when an operator attempts to enter data too rapidly. The data displayed on the Nixie panel must be verified by the FADAC operator as well as the fire direction officer. This step is essential in any system of checks with the FADAC, since it is the only positive means of detecting keyboard entry errors.

(3) *Failure to clean all six air filters.* The air filters used with FADAC should be cleaned at least once daily. If the FADAC is operated in a dusty or dirty environment, the air filters should be cleaned and changed more often. Failure to clean the air filters will cause increased FADAC downtime.

(4) *Failure to perform proper generator maintenance.* Two 3-kw, 400-hertz, 3-phase, 120/208-volt generators are authorized for each FADAC. Although only one generator is used to operate the FADAC, the second generator is authorized to insure operational capability at all times, including periods of generator maintenance. The generator must be grounded, and the two generators should be alternated every 12 or 24 hours to allow time for periodic maintenance in accordance with TM 5-6115-271-14 and TM 5-2805-203-14.

CHAPTER 5

DESTRUCTION OF EQUIPMENT

5–1. General

a. When it becomes necessary to abandon equipment during combat, the M18 computer and its associated and auxiliary equipment must be destroyed to prevent its use by the enemy.

b. The destruction of any equipment subject to capture will be ordered only by proper authority.

5–2. Principles

Plans must be prepared for destroying the computer and its associated and auxiliary equipment. The principles to be applied in planning are as follows:

a. Destruction methods must be easy to implement.

b. Destruction must be thorough.

c. Priorities must be applied so that the more essential parts are destroyed first.

d. The same essential parts on all like units must be destroyed to prevent the enemy from constructing a unit from salvaged parts.

e. Priorities established for the destruction of spare parts and accessories must be the same as those established for the destruction of like parts and accessories installed on the equipment.

5–3. Methods

a. The methods employed in the destruction of the computer will be specified in the destruction plan included in the unit standing operating procedures. Typical methods that should be considered in formulating a plan of destruction include destruction of equipment by the use of firearms, grenades, or TNT or other types of explosives and the destruction of parts by burning them or striking them with an axe, a sledge hammer, or a similar instrument.

b. The essential parts of the M18 computer are the circuit boards, the magnetic disc memory, and the control panel assembly. If time permits, the chassis can be removed from the case and the parts can be destroyed by smashing them with a sledge hammer. Each circuit board should be smashed. The computer may also be rendered useless by placing it on a pile of combustible material, pouring gasoline, oil, or a similar liquid over the computer, and igniting it. A hot fire is required. For further details on destruction means, refer to TM 9–1220–221–10.

APPENDIX A

REFERENCES

A-1. Field Manuals (FM)

5-25	Explosives and Demolitions.
6-15	Artillery Meteorology.
6-40	Field Artillery Cannon Gunnery.
6-125	Qualification Tests for Specialists, Field Artillery.

A-2. Technical Manuals (TM)

5-2805-203-14	Organizational, DS and GS Maintenance Manual: Engine, Gasoline.
5-6115-211-10	Operator's Manual: Generator Set, Gasoline Engine: 3kw, AC, 120V, 1 and 3 Phase, 120/240v, Single Phase, 120/208v, 3 Phase, 400 Hz, Skid Mounted.
5-6115-271-14	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Generator Set, Gasoline Engine, 3kw, AC, 400 Hz.
9-1220-221-10	Operator's Manual: Computer, Gun Direction, M18.
9-1220-221-20/1	Organizational Maintenance Manual: Computer, Gun Direction, M18.
9-1220-221-20P	Organizational Maintenance Repair Parts and Special Tools List for Computer, Gun Direction, M18.

A-3. Miscellaneous

AR 611-201	Enlisted Military Operational Specialties.
ATP 6-100	Field Artillery Cannon Units.
DA Pam 310-series	Indexes of Military Publications.

APPENDIX B

COMPUTER METEOROLOGICAL MESSAGE TAPE PREPARATION

B-1. General

a. Met message perforated tapes should be prepared for training the operators to solve sample problems. In actual operations, it is the function of the met section at a higher echelon to prepare and transmit the met message for use at unit level; however, tapes to be used for training may be prepared as outlined below.

★*b.* The gun direction computer M18 (FADAC) uses an international computer met message in its computations. This met message allows the computer to use data on the actual existing weather. The computer met message is different from the met message, used in the manual computation of firing data, in which the effects of one layer of atmosphere are weighted against the effects of lower layers, or zones, and then average effects are determined for each zone.

c. The entry of any data into FADAC is a function of the computer program; therefore, the met message must be in a format which conforms to the input portion of that program and the perforated tape must be in a specific format to be acceptable for input. Any deviation from the procedure for cutting the tape will cause the computer to reject the tape message.

d. The tape can be prepared by using the teletypewriter reperforator-transmitter TT/76GGC in the AN/GRC-46, AN/GRC-122, and AN/GRC-142 radio sets.

B-2. Procedures for Cutting a Training Met Message Tape

a. Advance the tape 4 to 5 inches by using the tape advance lever on the TT-76.

b. Cut the text of the message starting with the identification lines (12 digits each), and then cut the met data lines of the computer met message. Use 16 digits for each data line; use only *one carriage return* and *one line feed instruction* at the end of each line.

c. After cutting the last line of available met data, cut the digit 9 and one carriage return instruction. (The digit 9 is a stop instruction to FADAC.)

d. Advance the tape 3 to 4 inches by using the BLANK key or the tape advance lever on the TT-76.

Table B-1. Standard Computer Meteorological Message Tape Preparation Procedures

Message parts	Met message text	Machine functions	Remarks
		Advance the tape 4 to 5 inches by using the BLANK key on the TT-76 teletypewriter.	Blank position of the tape is used to thread the tape into the mechanical tape reader.
Introduction Valid time group	METCM0512018 070952031972	1CR, 1 LF 1CR, 1 LF	Identification lines
Body	0002000526621972 0102601026281940 0203002026021884 0305102225881862 * * * * 1018205025100548	1CR, 1 LF 1CR, 1 LF 1CR, 1 LF 1CR, 1 LF * * * 1CR, 1 LF	The carriage return code causes computer to store the 16 digits preceding the code.
	9	1CR	The digit 9 is a stop instruction.

Table B–1. Standard Computer Meteorological Tape Preparation Procedures—Continued

Message parts	Met message text	Machine functions	Remsrks
		Advance the tape 3 to 4 inches by using the BLANK key on the TT–76 teletypewriter.	

CR = carriage return
LF = line feed

APPENDIX C

AMMUNITION REFERENCE DATA

C-1. Standard Projectile Weights Used in the FADAC Solution

On some projectiles, weight is indicated by squares printed on the projectile. On other projectiles, the actual weight in pounds is stamped on the projectile if the actual weight varies from the standard weight. For still other projectiles, a standard weight is assumed for all projectiles of that type and no indication of weight is shown on the projectile. Standard weights of all projectiles are shown in the "Pounds" column of tables C-1 through C-4. For those projectiles on which weight is indicated by squares, the number of squares printed on standard weight projectiles is indicated in the "Squares" column. An explanation of the numbers in parentheses after the *pound* weight is as follows:

a. The number (1) indicates that the weight of the projectile, in squares, is stamped on the projectile. For the 105-mm howitzer projectile, a difference of one square from standard represents a difference of 0.6 pound; for the 155-mm howitzer projectile, a difference of 1.1 pounds; for the 8-inch howitzer, a difference of 2.5 pounds; and for the 175-mm gun, a difference of 1.1 pounds.

b. The number (2) means that the weight is not indicated on the projectile and, therefore, that the nominal weight shown in the table is used for computing firing data. (The standard weight for an M84 colored smoke projectile must be entered manually into the computer.)

c. The number (3) means that the actual weight of the projectile, *if it varies from standard,* is stamped on the projectile.

Table C-1. Standard Weights of Projectiles for 105-mm Howitzers M101A1, M102, and M108

Shell type	Model	Standard weights		Flag
		Squares	Pounds	
HE	M1	2	33.0 (1)	1
WP	M60	5	34.8 (1)	2
Smoke BE-HC	M84-series	--	32.9 (2)	3
Smoke BE Yellow	M84-series	--	30.3 (2)	3
Smoke BE Red	M84-series	--	30.7 (2)	3
Smoke BE Green	M84-series	--	30.5 (2)	3
Illum	M314-series	--	35.0 (2)	4
CS	XM629	--	33.6 (2)	7
HE (ICM)	M444	2	33.0 (1)	6
Gas (GB)	M360	6	35.4 (1)	9
Gas (H & HD)	M60	2	33.0 (1)	9

Table C-2. Standard Weights of Projectiles for 155-mm Howitzers M114A1 and M109

Shell type	Model	Standard weights		Flag
		Squares	Pounds	
HE	M107	4	95.0 (1)	1
WP	M110-series	6	97.2 (1)	2
Smoke BE	M116	--	86.4 (2)	3
Illum	M485	--	90.0 (2)	4
AE	M454	--	120.5 (3)	5
HE (ICM)	M449	4	95.5 (1)	6
HE (ICM)	M449A1 (E2)	4	95.7 (1)	7
HE (ICM)	M449E1	6	97.0 (1)	8
Gas (GB)	M121	8	99.4 (1)	9
Gas (GB & VX)	M121A1	8	99.4 (1)	9

Table C-3. Standard Weights of Projectiles for 8-inch Howitzers M110 and M110E1

Shell type	Model	Standard weights		Flag
		Squares	Pounds	
HE	M106	4	200.0 (1)	1
HES	M424	--	242.0 (3)	4
AE	M422	--	242.0 (3)	5
HE (ICM)	M404	4	201.0 (1)	6
Gas (GB or VX)	M426	4	200.0 (1)	9

Table C-4. Standard Weight of Projectile for 175-mm Guns M107 and M107E1

Shell type	Model	Standard weights		Flag
		Squares	Pounds	
HE	M437	3	147.8 (1)	1

Notes. 1. The variance from standard weight is indicated by small squares printed on the projectile. If the projectile is standard weight, a specific number of squares designates that it is standard, depending on the caliber and type of shell. Each square represents a weight zone depending on the caliber as follows: A weight difference of one square is 0.6 pound for the 105-mm howitzer, 1.1 pounds for the 155-mm howitzer, 2.5 pounds for the 8-inch howitzer, 1.1 pounds for the 175-mm gun.

2. Weight is not indicated on these projectiles. Standard nominal weights are used. Standard weight for colored smoke M84 must be entered manually.

3. The actual weight of this projectile is stamped on the projectile.

C-2. Charges and Standard Muzzle Velocities

The standard muzzle velocity for each charge used in artillery projectiles is shown in tables C-5 through C-10.

Table C-5. Standard Muzzle Velocities for 105-mm Howitzer M101A1

Flag	Proj	Type	Normal charges						
			1	2	3	4	5	6	7
1	HE	M1	195.1	211.8	233.2	262.1	301.8	365.8	464.8
2	WP	M60	195.1	211.8	233.2	262.1	301.8	365.8	464.8
3	Smoke	M84, M84B1	195.1	211.8	233.2	262.1	301.8	365.8	464.8
9	Gas	M360	195.1	211.8	233.2	262.1	301.8	365.8	464.8
4	Illum	M314	187.5	203.9	221.9	246.9	284.4	343.8	433.7
6	HE	M444	196.5	212.5	232.9	260.8	299.1	361.7	459.5
7	CS	XM629	191.3	207.9	226.2	251.5	289.6	349.8	441.0

Table C–6. Standard Muzzle Velocities for 105-mm Howitzers M102 and M108

Flag	Proj	Type	Normal charges						
			1	2	3	4	5	6	7
1	HE	M1	205.0	223.0	247.0	278.0	325.0	393.0	494.0
2	WP	M60	205.0	223.0	247.0	278.0	325.0	393.0	494.0
3	Smoke	M84, M84B1	205.0	223.0	247.0	278.0	325.0	393.0	494.0
9	Gas	M360	205.0	223.0	247.0	278.0	325.0	393.0	494.0
6	HE	M444	206.5	223.7	246.7	276.6	322.1	388.6	488.4
4	Illum	M314	187.0	208.0	232.0	263.0	309.0	374.0	468.0
7	CS	XM629	190.8	212.1	263.4	267.9	314.5	380.4	475.8

Table C–7. Standard Muzzle Velocities for 155-mm Howitzer M114A1

Flag	Proj	Type	Green bag propellant charges					White bag propellant charges				
			1	2	3	4	5	3	4	5	6	7
1	HE	M107	207.3	234.7	274.1	317.0	374.9	274.3	316.4	374.6	463.3	563.9
2	WP	M110-series	207.3	234.7	274.1	317.0	374.9	274.3	316.4	374.6	463.3	563.9
3	Smoke	M116	207.3	234.7	274.1	317.0	374.9	274.3	316.4	374.6	463.3	563.9
9	Gas	M121-series	207.3	234.7	274.1	317.0	374.9	274.3	316.4	374.6	463.3	563.9
4	Illum	M485	212.0	241.0	281.0	324.1	384.0	279.0	322.0	382.0	472.0	576.0
6	HE	M449	206.7	234.1	273.7	316.3	374.0	274.3	316.1	374.0	462.3	562.6
7	HE	M449A1	206.1	233.6	273.2	316.0	374.1	273.3	315.4	373.8	462.7	563.5
8	HE	M449E1	206.7	233.6	272.6	315.6	371.3	272.5	313.9	371.0	458.2	557.0
5	AE	M454	310.9	374.9	555.2	Propellant XM72						

Table C–8. Standard Muzzle Velocities for 155-mm Howitzer M109

Flag	Proj	Type	Green bag propellant charges					★White bag propellant charges				
			1	2	3	4	5	3	4	5	6	7
1	HE	M107	213.0	240.0	279.1	319.1	378.0	280.0	319.0	378.0	463.0	561.0
2	WP	M110	213.0	240.0	279.1	319.1	378.0	280.0	319.0	378.0	463.0	561.0
3	Smoke	M116	213.0	240.0	279.1	319.1	378.0	280.0	319.0	378.0	463.0	561.0
9	Gas	M121A1	213.0	240.0	279.1	319.1	378.0	280.0	319.0	378.0	463.0	561.0
4	Illum	M485	218.0	246.0	286.1	327.1	388.0	284.0	325.0	384.0	472.0	573.0
6	HE	M449	214.5	241.1	279.6	319.0	376.9	★279.0	318.8	376.9	460.5	556.9
7	HE	M449A1	211.8	238.9	278.1	318.1	377.2	179.0	318.1	377.2	462.4	560.6
8	HE	M449E1	212.4	238.9	277.4	316.7	374.4	278.2	316.5	374.4	457.9	554.1
5	AE	M454	310.0	374.9	550.6	Propellant XM72						

Table C–9. Standard Muzzle Velocities for 8-inch Howitzers M110 and M110E1

Flag	Proj	Type	Green bag propellant charges					White bag propellant*	
			1	2	3	4	5	6	7
1	HE	M106	249.9	274.3	304.3	350.5	420.6	499.9	594.4
4	HES	M424	254.5	359.7	547.1	--	--	--	--
5	AE	M422	251.5	356.9	543.9	--	--	--	--
6	HE	M404	249.9	274.3	304.8	349.3	418.2	497.1	591.3
9	Gas	M426	249.9	274.3	304.8	350.5	420.6	499.9	594.4

*White bag has the same MV as green bag propellant.

Table C-10. Standard Muzzle Velocities for 175-mm Guns M107 and M107E1

Flag	Proj	Type	Charges		
			1	2	8
1	HE	M473	510.5	704.1	914.4

Note. When firing charge 8, propellant charge M86 or M86A1, with the additive jacket XM1, use a correction of -2 meters per second in muzzle velocity.

C-3. Projectile-Fuze Combinations

The cannon computer program is capable of computing ballistic data for all projectile-fuze combinations normally used. The fuze flags that identify the models of fuzes that are safety certified to be fired with specific projectiles are indicated in *a* through *d* below. In some cases an additional correction must be considered and entered in the computer. Where such a correction is required, an index number in parentheses follows the fuze model number. The number (1) after fuze M78 and M78A1 indicates that 0.7 pound must be added to the projectile weight. The number (2) after VT fuzes M513 and M514 indicates that 0.5 pound must be added to the projectile weight. Other fuzes of the M513 and M514 series require no correction.

a. 105-mm Howitzers M101A1, M012, and M108.

(1) *HE projectile M1 (flag 1).*

Fuse type	*Flag*	*Fuse models*
PD	--	M51A4, M51A5, M78-series (1), M557
Time	2	M500A1, M520, M520A1
VT	8	M513 (2), all other M513 models, M514A1E1
Time	7	M564-series
(Capped) VT	8	M513-series with the desensitizing cap.

(2) *WP projectile M60 (flag 2).*

Fuse type	*Flag*	*Fuse models*
PD	1	M51A4, M51A5, M508, M508A1, M557
Time	7	M564-series

(3) *Smoke projectiles M84 and M84B1 (flag 3).*

Fuse type	*Flag*	*Fuse models*
Time	2	M501-series

(4) *Illuminating projectiles M314-series (flag 4).*

Fuse type	*Flag*	*Fuse models*
Time	2	M501-series
Time	7	M565-series, M548 only with shell M314A2E1

(5) *Gas projectile M360 (flag 9).*

Fuse type	*Flag*	*Fuse models*
PD	1	M51A1, M51A5, M508, M508A1, M557
Time	7	M564-series

(6) *HE projectile M444 (flag 6).*

Fuse type	*Flag*	*Fuse models*
Time	7	M548, M565-series

(7) *CS projectile XM629 (flag 7).*

Fuse type	*Flag*	*Fuse models*
Time	7	M548, M565-series

★*b. 155-mm Howitzer M114A1 and M109.*

(1) *HE projectile M107 (flag 1).*

Fuse type	*Flag*	*Fuse models*
PD	1	M51A4, M51A5, M78-series (1), M557
Time	2	M500A1, M520, M520A1
VT	3	M514(2), M514B1, M514A1E1
Time	7	M564-series

(2) *WP projectile M110 (flag 2).*

Fuse type	*Flag*	*Fuse models*
PD	1	M51A4, M51A5, M557
Time	2	M500A1, M520, M520A1
Time	7	M564

(3) *Smoke projectile M116 (flag 3).*

Fuse type	*Flag*	*Fuse models*
Time	2	M501A1

(4) *Illuminating projectiles M485, M485E1, M485E2 (flag 4).*

Fuse type	*Flag*	*Fuse models*
Time	7	M565-series

(5) *AE projectile M454 (flag 5).*

Fuse type	*Flag*	*Fuse models*
Spec VT	3	T361E2
Spec MT	5	XM32E1, T361E2

(6) *HE projectile M449 (flag 6).*

Fuse type	*Flag*	*Fuse models*
Time	7	M548, M565-series

(7) *HE projectile M449A1 (flag 7).*

Fuse type	*Flag*	*Fuse models*
Time	7	M548, M565-series

(8) *HE projectile M449E1 (flag 8).*

Fuse type	*Flag*	*Fuse models*
Time	7	M548, M565-series

(9) *Gas projectiles M121 and M121A1 (flag 9).*

Fuse type	*Flag*	*Fuse models*
PD	1	M508-series, M557

c. 8-Inch Howitzers M110 and M110E1.

(1) *HE projectile M106 (flag 1).*

Fuze type	*Flag*	*Fuze models*
PD	1	M51A4, M51A5, M78-series (1), M557
Time	2	M500A1, M520, M520A1
VT	3	M514 (2), M514A1, M514B1, M514A1E1
Time	7	M564-series

(2) *HES projectile, spotting, M424 (flag 4).*

Fuze type	*Flag*	*Fuze models*
Spec MT	5	M543, M543A1

(3) *AE projectile M422 (flag 5).*

Fuze type	*Flag*	*Fuze models*
Spec MT	5	M542

(4) *HE projectile M404 (flag 6).*

Fuze type	*Flag*	*Fuze models*
Time	7	M548, M565-series

(5) *Gas projectile M426 (flag 9).*

Fuze type	*Flag*	*Fuze models*
PD	1	M508, M508A1
VT	3	M514A1, M514A1E1

d. 175-mm Guns M107 and M107E1, HE Projectiles M437, M437A1, M437A2 (Flag 1).

Fuze type	*Flag*	*Fuze models*
PD	1	M572
VT	3	M514A1, M514A1E1

Notes. 1. CP fuzes M78 and M78A1: Add 0.7 pound to projectile weight.

2. VT fuzes M513 and M514: Add 0.5 pound to the projectile weight. Other models of this series require no correction.

APPENDIX D

SAMPLE PROBLEMS

D-1. General

This appendix contains sample problems which may be used for operator training and for checking the operation of the computer. The solutions are valid for revision 4 of the cannon machine programs.

★D-2. Setup and Testing

First, program tests 1 and 2 described in section IV, chapter 2, should be made to insure that the computer is properly programmed. Second, the setup procedures described in the entry procedures for matrix functions E-2 (SET UP) in table 2-1 should be used to set up the desired series weapon data for each battery button. Third, E-1 (EOM) and H-6 (MET STD) should be enabled by entering 0 for each function to eliminate unwanted data that may have been previously stored in the computer's memory. Fourth, the techniques described in paragraph 2-26 should be used to clear the no-fire area list to preclude a false indication of a violation.

Note. When data for all calibers of weapons are shown in the sample problems, as in paragraph D-3*a*(4), only the data for one caliber will be entered in, or displayed by, the computer.

D-3. Battery Adjust-Fire Mission

a. Battery A has occupied a new firing position and is ready to fire. The following data are known:

(1) Map-inspected coordinates of the battery center: 4349 3437.

(2) Altitude: 409 meters.

(3) Azimuth of lay: 60 mils.

(4) Referred deflections:

105-mm M101A1	2800
105-mm M102, M108	3200
155-mm M114A1	2400
155-mm M109	3200
8-inch M110	3200
175-mm M107	3200

(5) Muzzle velocity and meteorological data: Unknown.

(6) Powder temperature: +27° F.

(7) Projectile weight: Standard.

(8) Latitude: 34° North.

★*b.* The S3 directs the computer operator to enter the known data in the computer. The data are entered as follows:

(1) Depress the battery A button.

(2) Depress matrix buttons H-1 (BTRY EAST).

(3) Depress the SM key.

(4) Type 43490 on the keyboard. Check the Nixie display; then depress the ENTER key.

(5) Depress matrix buttons H-2 (BTRY NORTH).

(6) Depress the SM key.

(7) Type 34370 on the keyboard. Check the Nixie display; then depress the ENTER key.

(8) Depress matrix buttons H-3 (BTRY ALT).

(9) Depress the SM key.

(10) Type 409 on the keyboard. Check the Nixie display; then depress the ENTER key.

(11) Depress matrix buttons H-4 (BTRY AZ LAID).

(12) Depress the SM key.

(13) Type 60 on the keyboard. Check the Nixie display; then depress the ENTER key.

(14) Depress matrix buttons H-5 (BTRY DF).

(15) Depress the SM key.

(16) On the keyboard, type the referenced deflection for the caliber and type of weapon being used (para D-3*a*(4)). Check the Nixie display; then depress the ENTER key.

(17) Depress matrix buttons G-2 (POWD TEMP).

(18) Depress the SM key.

(19) Type +27 on the keyboard. Check the Nixie display; then depress the ENTER key.

(20) Depress matrix buttons G-4 (LAT).

(21) Depress the SM key.

(22) Type +34 on the keyboard. Check the Nixie display; then depress the ENTER key.

Note. The projectile weight, muzzle velocity, and meteorological functions would have been set to standard during the setup procedure; therefore, no entries are required for these elements at this time.

c. The S3 directs the computer operator to enter the following no-fire areas in the computer:

Area number	*Activity*	*Coordinates*	*Safe radius*
1	Village	48160 43000	800 meters
2	Village	42270 50160	1,000 meters
3	Friendly patrol	44880 43390	200 meters

d. The data are entered as follows:

(1) Depress matrix buttons F-1 (NO-FIRE AREA EAST).

(2) Depress the SM key.

(3) Type 48160 on the keyboard and depress the ENTER key.

(4) Depress matrix buttons F-2 (NO-FIRE AREA NORTH).

(5) Depress the SM key.

(6) Type 43000 on the keyboard and depress the ENTER key.

(7) Depress matrix buttons F-3 (NO-FIRE AREA RADIUS).

(8) Depress the SM key.

(9) Type 800 on the keyboard and depress the ENTER key.

(10) Depress matrix buttons F-4 (NO-FIRE AREA STORE).

(11) Depress the SM key.

(12) Type 1 on the keyboard and depress the ENTER key.

(13) Repeat the procedures in (1) through (12) above to enter the other no-fire areas.

e. The fire direction center receives the following call for fire and the S3 issues the fire order:

Call for fire	*Fire order*	*VCO data*
FIRE MISSION, GRID 44520 43310,	ALFA,	Target altitude,
DIRECTION 6200,	2 ROUNDS	435 meters.
PLATOON OF INFANTRY, ADJUST FIRE.	TARGET AB 1010.	

★*f.* The target location and firing data are entered as follows:

(1) Insure that the Battery A button is depressed.

(2) Depress matrix buttons A-1 (TGT) EAST).

(3) Depress the SM key.

(4) Type 44520 on the keyboard; then depress the ENTER key.

(5) Depress matrix buttons A-2 (TGT NORTH).

(6) Depress the SM key.

(7) Type 43310 on the keyboard; then depress the ENTER key.

(8) Depress matrix buttons A3 (TGT ALT).

(9) Depress the SM key.

(10) Type 435 on the keyboard; then depress the ENTER key.

(11) Depress the COMPUTE button. The appropriate one of the following solutions will be displayed:

Weapon type	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	7	2753	32.1	460
105-mm M102, M108	7	3154	30.5	418
155-mm M114	7	2350	24.9	279
155-mm M109	7	3150	25.0	281
8-inch M110	6	3152	26.7	330
175-mm M107	1	3147	24.9	285

Note. Depress the RECEIVE button to erase the leading zeros.

g. The observer transmits RIGHT 180. Data are entered as follows:

(1) Depress matrix buttons A-5 (OT DIR).

(2) Depress the SM key.

(3) Type 6200 on the keyboard; then depress the ENTER key.

(4) Depress matrix buttons A-6 (RIGHT/LEFT).

(5) Depress the SM key.

(6) Type RIGHT 180 on the keyboard; then depress the ENTER key.

(7) Depress the TRIG button. The NO SOLUTION indicator will blink but the COMPUTE indicator will remain on to indicate that a no-fire area will be violated if the following displayed gun data are fired:

Weapon type	Charge	Deflection	Time	Quadrant elevation
105-mm M101A1	7	2733	32.4	465
105-mm M102, M108	7	3135	30.8	422
155-mm M114A1	7	2331	25.2	282
155-mm M109	7	3131	25.2	284
8-inch M110	6	3132	26.9	333
175-mm M107	1	3128	25.1	288

(8) Depress matrix buttons F-4 (NO-FIRE AREA STORE).

(9) Depress the RECALL key, type 40 on the keyboard, and depress the ENTER key. The number 3 will be displayed to indicate that no-fire area 3 will be violated.

(10) Depress the RECEIVE button to recall the gun data.

h. The S3 is informed that the patrol has exited no-fire area number 3. He informs the computer operator that it is now safe to fire in that area. The firing commands are sent to the firing battery and the initial adjusting rounds are fired.

i. The observer transmits ADD 200. The data are entered as follows:

(1) Depress matrix buttons A-7 (ADD/DROP).

(2) Depress the SM key.

(3) Type ADD 200 on the keyboard; then depress the ENTER key.

(4) Depress the TRIG button. The following solution will be displayed:

Weapon type	Charge	Deflection	Time	Quadrant elevation
105-mm M101A1	7	2741	33.5	483
105-mm M102, M108	7	3142	31.8	438
155-mm M114A1	7	2339	25.9	291
155-mm M109	7	3139	25.9	293
8-inch M110	6	3140	27.6	344
175-mm M107	1	3135	25.8	297

j. The observer transmits DROP 100. The data are entered as follows:

(1) Insure that matrix buttons A-7 (ADD/DROP) are depressed.

(2) Depress the SM key.

(3) Type DROP 100 on the keyboard; then depress the ENTER key.

(4) Depress the TRIG button. The following solution will be displayed:

Weapon type	Charge	Deflection	Time	Quadrant elevation
105-mm M101A1	7	2737	32.9	474
105-mm M102, M108	7	3138	31.3	430
155-mm M114A1	7	2335	25.5	286
155-mm M109	7	3135	25.5	288
8-inch M110	6	3136	27.3	338
175-mm M107	1	3132	25.4	293

k. The observer transmits ADD 50, FIRE FOR EFFECT. The data are entered as follows:

(1) Insure that matrix buttons A-7 (ADD/DROP) are depressed.

(2) Depress the SM key.

(3) Type ADD 50 on the keyboard; then depress the ENTER key.

(4) Depress the TRIG button. The following fire-for-effect solution will be displayed:

Weapon type	Charge	Deflection	Time	Quadrant elevation
105-mm M101A1	7	2739	33.2	478
105-mm M102, M108	7	3140	31.5	434
155-mm M114A1	7	2337	25.7	289
155-mm M109	7	3137	25.7	291
8-inch M110	6	3138	27.5	341
175-mm M107	1	3134	25.6	295

l. The observer transmits END OF MISSION and reports his surveillance. The S3 directs that the target be stored as target number 1. The data for storing the target are entered as follows:

(1) Depress matrix buttons A-4 (TGT STORE).

(2) Depress the SM key.

(3) Type 1 on the keyboard; then depress the ENTER key. Coordinates 44667 43492 and the altitude 435 will be displayed.

Note. The adjusted location of target 1 includes the errors resulting from the use of standard met and muzzle velocity data; however, the "did hit" gun data should be noted. This "did hit" data can be used to update the target location as soon as the weather and muzzle velocity values have been entered. If a change in the weather conditions occurs before the target location has been updated, it may be necessary to fire check rounds on the target to verify the accuracy of the "did hit" data.

m. The mission is terminated as follows:

(1) Depress matrix buttons E-1 (EOM).

(2) Depress the SM key.

(3) Type 0 on the keyboard.

n. The S3 directs the computer operator to delete no-fire area number 3. The data are entered as follows:

(1) Depress matrix buttons F-1 (NO-FIRE AREA EAST).

(2) Depress the SM key.

(3) Type 00000 on the keyboard and depress the ENTER key.

(4) Depress matrix buttons F–2 (NO-FIRE AREA NORTH).

(5) Depress the SM key.

(6) Type 00000 on the keyboard and depress the ENTER key.

(7) Depress matrix buttons F–3 (NO-FIRE AREA RADIUS).

(8) Depress the SM key.

(9) Type 00000 on the keyboard and depress the ENTER key.

(10) Depress matrix buttons F–4 (NO-FIRE AREA STORE).

(11) Depress the SM key.

(12) Type 3 on the keyboard and depress the ENTER key to delete no-fire area number 3.

Note. The steps described in *n*(11) and (12) above may be repeated to delete other specific NO-FIRE areas that are no longer valid. In this problem, clear no-fire areas 2 and 3, since they are no longer needed.

D–4. Registration

a. Battery A has occupied position; however, the fire direction center has not received a meteorological message and muzzle velocity data are unknown. The S3 decides to register with a specific charge. Coordinates of registration point 1 are 41196 43137; altitude of the registration point is 457 meters.

★*b.* The data presented in paragraph D–3*a* are known.

★*c.* Enter the battery data by following the procedures outlined in paragraph D–3*b* and enter the coordinates of the registration point by following the steps outlined in paragraph D–3*f*(1) through (10). Then store the registration point as target number 2 and enter the charge override.

d. Data are entered as follows:

(1) Depress matrix buttons A–4 (TGT STORE).

(2) Depress the SM key.

(3) Type 2 on the keyboard and depress the ENTER key. Coordinates 41196 43137 and altitude 457 will be displayed.

(4) Depress matrix buttons B–1 (CHG).

(5) Depress the SM key.

(6) Type the selected charge on the keyboard and depress the ENTER key.

Caliber	*Charge*
105-mm	7
155-mm	6
8-inch	5
175-mm	1

(7) Depress the COMPUTE button and the following initial data will be displayed:

Weapon type	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	7	3130	32.5	469
105-mm M102, M108	7	3531	30.9	427
155-mm M114A1	6	2731	29.9	409
155-mm M109	6	3531	29.8	409
8-inch M110	5	3529	30.7	447
175-mm M107	1	3525	25.1	291

Note. Time displayed will be the time of flight.

e. During the adjustment phase, the operator uses the M18 computer to calculate firing data. When the observer enters the fire-for-effect phase, the FDC determines the following adjusted data by manual computations:

Weapon type	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	7	3136		481
105-mm M102, M108	7	3535		434
155-mm M114A1	6	2740		419
155-mm M109	6	3538		422
8-inch M110	5	3535		460
175-mm M107	1	3531		310

f. Requirement. Since the coordinates of the target, input through matrix functions A–1, A–2, and A–3, were changed during the adjustment phase, the operator must recall the surveyed coordinates and altitude of the registration point.

★*g. Solution.*

(1) Depress matrix buttons A–4 (TGT STORE).

(2) Depress the RECALL key.

(3) Type 2 on the keyboard and depress the ENTER key. Coordinates 41196 43137 and altitude 457 will be displayed.

(4) Depress matrix buttons B–1 (CHG).

(5) Depress the SM key.

(6) Type the specific charge on the keyboard and depress the ENTER key.

(7) Depress matrix buttons G–6 (DF INPUT).

(8) Depress the SM key.

(9) On the keyboard, type the adjusted de-

flection for the weapon concerned (*e* above) and depress the ENTER key.

(10) Depress matrix buttons G-8 (QE INPUT).

(11) Depress the SM key.

(12) On the keyboard, type the adjusted QE for the weapon concerned (*e* above) and depress the ENTER key.

(13) Depress matrix buttons H-8 (COMP REG).

(14) Depress the SM key. The following data will be computed and displayed and the KEYBOARD indicator will remain on.

Weapon type	*Deflection correction*	*Range K*
105-mm M101A1	(−) L 5.4	+14
105-mm M102, M108	(−) L 3.3	+10
155-mm M114A1	(−) L 8.4	+15
155-mm M109	(−) L 7.0	+20
8-inch M110	(−) L 6.1	+19
175-mm M107	(−) L 5.7	+42

(15) Type the specific charge on the keyboard and depress the ENTER key. The display will reappear and the KEYBOARD indicator will remain on.

(16) Depress the decimal point (.) key and the display will disappear. Then depress the ENTER key. The KEYBOARD indicator will go out and the mode will be ended.

Note. Now enter registration corrections for Battery A for low-angle fire with the specific charge entered in the step discussed in (15) above.

(17) End the mission by repeating the actions described in paragraph D-3*m*.

D-5. Traverse Survey

a. The battalion survey party has completed the field work for battery A position.

b. The survey officer brought the following field notes of a traverse into the fire direction center:

SCP	44963.61 31694.50
Altitude	418.8
Azimuth SCP-TS 1	5598.1 mils
Distance SCP-TS 1	918.06 meters
Vertical angle SCP-TS 1	-2.6 mils
Azimuth TS 1 - TS 2	692.5 mils
Distance TS 1 - TS 2	1121.87 meters
Vertical angle TS 1 - TS 2	-4.4 mils
Azimuth TS2 - TS 3	5858.7 mils
Distance TS 2 - TS 3	995.08 meters
Vertical angle TS 2 - TS 3	-3.3 mils
Azimuth TS 3 - BC	5008.3 mils
Distance TS 3 - BC	1120.62 meters
Vertical angle TS 3 - BC	-2.5 mils

c. The operator is directed by the S3 to compute the coordinates of the battery center and to record the coordinates of the various stations of the traverse survey.

d. Data are entered as follows:

(1) Depress matrix buttons C-1 (OBS EAST).

(2) Depress the SM key.

(3) On the keyboard, type 44963.61; then depress the ENTER key.

(4) Depress matrix buttons C-2 (OBS NORTH).

(5) Depress the SM key.

(6) One the keyboard, type 31694.50; then depress the ENTER key.

(7) Depress matrix buttons C-3 (OBS ALT).

(8) Depress the SM key.

(9) On the keyboard, type 418.80; then depress the ENTER key.

(10) Depress matrix buttons C-4 (OBS DIR).

(11) Depress the SM key.

(12) On the keyboard, type 5598.10; then depress the ENTER key.

(13) Depress matrix buttons C-5 (OBS HORIZ DIST).

(14) Depress the SM key.

(15) On the keyboard, type 918.06; then depress the ENTER key.

(16) Depress matrix buttons C-7 (OBS VERT ANGLE).

(17) Depress the SM key.

(18) On the keyboard, type -2.6; then depress the ENTER key.

(19) Depress matrix buttons D-5 (SURVEY).

(20) Depress the SM key.

(21) On the keyboard, type 1; then depress the ENTER key. The coordinates and altitude of traverse station 1 will be displayed: 44313 32342,417.

e. Additional data entered as follows:

(1) Depress matrix buttons C-4 (OBS DIR).

(2) Depress the SM key.

(3) On the keyboard, type 692.50; then depress the ENTER key.

(4) Depress matrix buttons C-5 (OBS HORIZ DIST).

(5) Depress the SM key.

(6) On the keyboard, type 1121.87; then depress the ENTER key.

(7) Depress matrix buttons C-7 (OBS VERT ANGLE).

(8) Depress the SM key.

(9) On the keyboard, type -4.40; then depress the ENTER key.

(10) Depress matrix buttons D-5 (SURVEY).

(11) Depress the SM key.

(12) On the keyboard, type 1; then depress the ENTER key. The coordinates and altitude of traverse station 2 will be displayed: 45019 33215, 412.

★*f*. Additional data entered as follows:

(1) Depress matrix buttons C-4 (OBS DIR).

(2) Depress the SM key.

(3) On the keyboard, type 5858.70; then depress the ENTER key.

(4) Depress matrix buttons C-5 (OBS HORIZ DIST).

(5) Depress the SM key.

(6) On the keyboard, type 995.08; then depress the ENTER key.

(7) Depress matrix buttons C-7 (OBS VERT ANGLE).

(8) Depress the SM key.

(9) On the keyboard, type -3.30; then depress the ENTER key.

(10) Depress matrix buttons D-5 (SURVEY).

(11) Depress the SM key.

(12) On the keyboard, type 1; then depress the ENTER key. The coordinates and altitude of traverse station 3 will be displayed: 44514 34073, 409.

g. Data entered as follows:

(1) Depress matrix buttons C-4 (OBS DIR).

(2) Depress the SM key.

(3) On the keyboard, type 5008.30; then depress the ENTER key.

(4) Depress matrix buttons C-5 (OBS HORIZ DIST).

(5) Depress the SM key.

(6) On the keyboard, type 1120.62; then depress the ENTER key.

(7) Depress matrix buttons C-7 (OBS VERT ANGLE).

(8) Depress the SM key.

(9) On the keyboard, type -2.50; then depress the ENTER key.

(10) Depress matrix buttons D-5 (SURVEY).

(11) Depress the SM key.

(12) On the keyboard, type 1; then depress the ENTER key. The coordinates and altitude of the battery center will be displayed: 43417 34300, 406.

h. *Discussion*. The coordinates and altitude displayed during the process of computing the survey are rounded values and are displayed to the nearest meter. If, for some reason, accuracy is desired to the nearest hundredth of a meter, recall the observer easting, observer northing, and observer altitude, in turn, prior to computing a new traverse station.

D-6. Battalion Missions

a. The battalion has now occupied positions, and the battalion survey has been completed.

★*b*. The following accurate data are available:

	Battery A	*Battery B*	*Battery C*
Coordinates	43417 34300	43906 34682	43462 34603
Altitude	406	395	398
Direction of fire	60	60	60
Latitude	34° N	34° N	34° N
Grid declination	+5 mils	+5 mils	+5 mils

Deflection—(Use deflections shown in paragraph D-3*a*(4)).

c. Enter the battalion data as follows:

(1) Depress the A battery button.

(2) Depress matrix buttons H-1 (BTRY EAST).

(3) Depress the SM key.

(4) On the keyboard, type 43417; then depress the ENTER key.

(5) Depress matrix buttons H-2 (BTRY NORTH).

(6) Depress the SM key.

(7) On the keyboard, type 34300; then depress the ENTER key.

(8) Depress matrix buttons H-3 (BTRY ALT).

(9) Depress the SM key.

(10) On the keyboard, type 406; then depress the ENTER key.

(11) Depress matrix buttons H-4 (BTRY AZ LAID).

(12) Depress the SM key.

(13) On the keyboard, type 60.

(14) Depress the ENTER key.

(15) Depress matrix buttons H-5 (BTRY DF).

(16) Depress the SM key.

(17) On the keyboard, type the referred deflection for the caliber and type weapon being used (para D-3*b*(4)).

(18) Depress matrix buttons G-4 (LAT).

(19) Depress the SM key.

(20) On the keyboard, type +34.

(21) Depress the ENTER key.

(22) Depress matrix buttons G-5 (GRID DECL).

(23) Depress the SM key.

(24) On the keyboard, type +5.

(25) Depress the ENTER key.

Note. The latitude and the grid declination angle need not be entered for the other batteries since they are nonbattery associated functions. Their entry for one battery suffices for all batteries.

d. The operator enters B battery and C battery data by repeating the actions in *c*(1) through (17) above using the appropriate data for the battery concerned. To insure that the computer is cleared of any overrides—

(1) Depress the A battery button.

(2) Depress matrix buttons E-1 (EOM).

(3) Depress the SM key.

(4) On the keyboard, type 0.

(5) After depressing each of the other battery buttons in turn, repeat (2), (3), and (4) above.

★*e.* The following additional data is reported:

(1) Muzzle velocity—Shell HE, Lot T (105), TZ (155, 8", 175).

		A	*B*	*C*
105-mm	Chg 6	359.6	375.4	356.2
	Chg 7	457.8	456.1	454.9
155-mm	Chg 5	370.0	368.2	367.1
	Chg 6	460.2	459.1	457.6
8-inch	Chg 5	417.6	414.6	412.0
	Chg 6	495.0	490.9	488.0
175-mm	Chg 1	498.1	505.0	496.2

(2) Power temperature all calibers.

A	*B*	*C*
+28	+29	+26

(3) Projectile weights.

	A	*B*	*C*
105-mm Shell HE	33.6	33.6	34.2
Shell WP	35.4	35.4	35.4
155-mm Shell HE	93.9	96.1	97.2
8-inch Shell HE	200.0	202.5	205.0
175-mm Shell HE	148.9	150.0	150.0

(4) Meteorological message.

Introduction

Identification	Octant	Location	Date-Time	Station Height (10's M)	MDP Pressure (mbs)
METCM	1	341981	261620	036	987

BODY

Line number	Wind direction (10's mils)	Wind speed (knots)	Temperature (1/10°K)	Pressure (mbs)
00	010	011	2693	0987
01	048	019	2679	0974
02	032	014	2673	0954
03	056	037	2617	0898
04	014	015	2672	0838
05	540	014	2718	0793
06	512	022	2707	0741
07	516	033	2672	0692
08	504	060	2672	0649
09	492	070	2657	0612
10	491	065	2616	0573
11	490	060	2580	0537
12	485	060	2542	0485
13	475	055	2483	0425
14	480	052	2410	0369
15	490	055	2327	0319
16	500	060	2248	0276
17	550	058	2192	0226
18	601	036	2141	0202
19	614	035	2106	0172
20	587	032	2119	0144

★*f.* Data entered as follows:

(1) Depress the Battery A button.

(2) Depress matrix buttons G-1 (MV).

(3) Depress the SM key.

(4) On the keyboard, type 16 (shell HE, charge 6); depress the ENTER key. The keyboard light remains lighted.

(5) On the keyboard, type 359.6 and depress the ENTER key.

(6) Depress the SM key.

(7) On the keyboard, type 17 (shell HE, charge 7); and depress the ENTER key; keyboard light remains lighted.

(8) On the keyboard, type 457.8 and depress the ENTER key.

(9) Depress matrix buttons G-2 (POWD TEMP).

(10) Depress the SM dey.

(11) On the keyboard, type +28 and depress the ENTER key.

(12) Depress matrix buttons G-3 (PROJ WEIGHT).

(13) Depress the SM key.

(14) On the keyboard, type 1 and depress the ENTER key; keyboard light remains lighted.

(15) On the keyboard, type 33.6 and depress the ENTER key.

(16) Depress the SM key.

(17) On the keyboard, type 2 and depress the ENTER key; the keyboard light remains lighted.

(18) On the keyboard, type 35.4 and depress the ENTER key.

Note. In (2) through (18) above, data apply to the 105-mm howitzer. Use the appropriate values for other calibers.

(19) Repeat actions (2) through (18) above with the B and C battery buttons depressed in turn and using the data associated with that battery.

(20) Depress matrix buttons E-4 (MET INPUT).

(21) Depress the SM key.

(22) On the keyboard, type 0; then depress the ENTER key. The number 88 will be displayed on the Nixie tubes.

(23) On the keyboard, type the identification line of the met message, starting with the date-time group 261620 036986.

(24) Depress the ENTER key. The number 00 will be displayed to indicate that the computer is ready for the 00 line of the message.

(25) On the keyboard, type the 00 line of the met message: 00 010 011 2693 0987.

(26) Depress the ENTER key. The number 01 will be displayed.

(27) On the keyboard, type the 01 line of the met message: 01 048 019 2679 0974.

(28) Depress the ENTER key. The number 02 will be displayed.

(29) Each succeeding line is entered by continuing this procedure until the last line has been entered. The input mode is terminated by typing the digit (9) on the keyboard and depressing the ENTER key.

Note. The data entered in the computer at this time meet the requirements for accurate unobserved surprise fire, using the shell and the propellant charges for which the muzzle velocity has been entered. The computer now has the capability of massing the fires of batteries A, B, and C on a target.

g. Insure that previously stored registration corrections are *not used* and enter the following data:

(1) Depress the "A" battery button.

(2) Depress matrix buttons H-7 (ZERO CORR).

(3) Depress the SM key.

(4) On the keyboard, type 0.

(5) Repeat (2) through (4) above for each of the other batteries by depressing the "B" and "C" buttons in turn.

h. The following radar (observer) location is reported. This data should be entered to permit rapid target locations using polar plot methods: Coordinates 49150 40250 510.

(1) Depress matrix buttons C-1 (OBS EAST).

(2) Depress the SM key.

(3) On the keyboard, type 49150; then depress the ENTER key.

(4) Depress matrix buttons C-2 (OBS NORTH).

(5) Depress the SM key.

(6) On the keyboard, type 40250; then depress the ENTER key.

(7) Depress matrix buttons C-3 (OBS ALT).

(8) Depress the SM key.

(9) On the keyboard, type 510; then depress the ENTER key.

(10) Depress matrix buttons D-3 (OBS LOC STORE).

(11) Depress the SM key.

(12) On the keyboard, type 3 then depress the ENTER key. The coordinates are displayed. The radar location is now stored as observer number 3.

i. The following fire mission is received from the radar section:

Call for fire	*S3 fire order*
Direction 500	Battalion
Distance 2000	Lot T (TZ)
Vertical angle −20	Charge: 7 (105), 6 (155), 5 (8″), 1 (175)
Assembly area, fire for effect.	Target AB 1050

j. Process the mission as follows:

(1) Depress the "A" battery button.

(2) Depress matrix buttons D-3 (OBS LOC STORE).

(3) Depress the RECALL key.

(4) On the keyboard, type 3; then depress the ENTER key. The coordinates and altitude of the radar are displayed (49150 40250 510).

(5) Depress matrix buttons C-4 (OBS DIR).

(6) Depress the SM key.

(7) On the keyboard, type 500; then depress the ENTER key.

(8) Depress matrix buttons C-6 (OBS SLANT DIST).

(9) Depress the SM key.

(10) On the keyboard, type 2000; then depress the ENTER key.

(11) Depress matrix buttons C-7 (OBS VERT ANGLE).

(12) Depress the SM key.

(13) On the keyboard, type -20; then depress the ENTER key.

(14) Depress matrix buttons C-8 (POLAR PLOT MISSION).

(15) Depress the SM key. The computer computes and displays the coordinates and altitude of the target and associates these data with the target input positions A-1, A-2, and A-3, respectively. Coordinates 50093 42014 and altitude 471 are displayed.

(16) Depress matrix buttons B-1 (CHG).

(17) Depress the SM key.

(18) On the keyboard, type 7(105), 6(155), 5(8″), 1(175), and depress the ENTER key.

(19) Depress the COMPUTE button. The following solution will be displayed for A battery:

Weapon type	*Battery*	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	A	7	2158	43.3	675
105-mm M102, M108	A	7	2562	43.2	674
155-mm M114A1	A	6	1753	37.5	537
155-mm M109	A	6	2552	37.3	536
8-inch M110	A	5	2549	38.9	595
175-mm M107	A	1	2542	31.2	385

(20) Depress matrix buttons B-8 (MASS FIRES).

(21) Depress the SM key.

(22) On the keyboard, type 23 and depress the ENTER key.

(23) Depress the B battery button.

(24) Depress matrix buttons B-1 (CHG).

(25) Depress the SM key.

(26) On the keyboard, type 7(105), 6(155), 5(8″), or 1(175) and depress the ENTER key.

(27) Depress the COMPUTE button. The following solution will be displayed for B battery.

Weapon type	*Battery*	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	B	7	2166	38.7	594
105-mm M102, M108	B	7	2569	38.6	594
155-mm M114A1	B	6	1763	34.4	491
155-mm M109	B	6	2563	34.3	490
8-inch M110	B	5	2560	35.8	548
175-mm M107	B	1	2554	28.7	347

(28) Depress the C battery button and repeat (24), (25), (26), and (27) above. The following solution will be displayed:

Weapon type	*Battery*	*Charge*	*Deflection*	*Time*	*Quadrant elevation*
105-mm M101A1	C	7	2139	41.5	644
105-mm M102, M108	C	7	2543	41.3	643
155-mm M114A1	C	6	1735	36.4	525
155-mm M109	C	6	2535	36.2	524
8-inch M110	C	5	2532	38.2	594
175-mm M107	C	1	2525	30.4	377

D-7. Intersection Survey

a. The battalion survey party completed part of the target area survey.

b. The following data are known:

Location	*Coordination*	*Altitude*
01	49150 40250	510
02	50012 39986	483

c. The following data are reported to the survey officer:

(1) 01 Azimuth to target 1Ø: 816 mils
Vertical angle: −6.1 mils

(2) 02 Azimuth to target 1Ø: 128 mils

d. The FADAC operator is directed to compute the coordinates of target 1Ø.

★e. Using the actions described in paragraph D-6*h*, store the 01 coordinates and altitude as observer 1 data and the 02 coordinates and altitude as observer 2 data.

f. Data entered as follows:

(1) Depress matrix buttons D-3 (OBS LOC STORE).

(2) Depress the RECALL key.

(3) On the keyboard, type 1 and depress the ENTER key. (The coordinates and altitude of 01 are displayed.)

(4) Depress matrix buttons C-4 (OBS DIR).

(5) Depress the SM key.

(6) On the keyboard type 816 and depress the ENTER key.

(7) Depress matrix buttons C-7 (OBS VERT ANGLE).

(8) Depress the SM key.

(9) On the keyboard type -6.1 and depress the ENTER key.

(10) Repeat (1) through (6) above for observer 2, using the appropriate data.

(11) Depress matrix buttons D-5 (SURVEY).

(12) Depress the SM key.

(13) On the keyboard type 2 and depress the ENTER key. The compute indicator lights and the following solution is displayed: 50170 41239, 502.

D-8. Orientation of Observers

a. The S3 desires observer orienting data to the selected location for a high burst registration.

b. The following data are known:

	Coordinates	*Altitude*
HB	50000 44000	500
01	49150 40250	510
02	50012 39986	483

c. Orienting data for 01 and 02 to the high burst (HB) location.

d. Process the data as follows:

(1) Depress matrix buttons A-1 (TGT EAST).

(2) Depress the SM key.

(3) On the keyboard type 50000 and depress the ENTER key.

(4) Depress matrix buttons A-2 (TGT NORTH).

(5) Depress the SM key.

(6) On the keyboard type 44000 and depress the ENTER key.

(7) Depress matrix buttons A-3 (TGT ALT).

(8) Depress the SM key.

(9) On the keyboard type 500 and depress the ENTER key.

Note. If the coordinates and altitude of the observers were previously stored in memory, (para D-7), (10) through (22) may be omitted.

(10) Depress matrix buttons C-1 (OBS EAST).

(11) Depress the SM key.

(12) On the keyboard type 49150 and depress the ENTER key.

(13) Depress matrix buttons C-2 (OBS NORTH).

(14) Depress the SM key.

(15) On the keyboard type 40250 and depress the ENTER key.

(16) Depress matrix buttons C-3 (OBS ALT).

(17) Depress the SM key.

(18) On the keyboard type 510 and depress the ENTER key.

(19) Depress matrix buttons D-3 (OBS LOC STORE).

(20) Depress the SM key.

(21) On the keyboard type 1 (or the assigned observer number 1-9) and depress the ENTER key.

(22) Repeat (10) through (21) above to enter the appropriate data for 02.

(23) Depress matrix buttons D-3 (OBS LOC STORE).

(24) Depress the RECALL key.

(25) On the keyboard type 1 and depress the ENTER key (coordinates and altitude of 01 are displayed).

(26) Depress the RECALL key.

(27) On the keyboard type 2 and depress the ENTER key (coordinates and altitude of 02 are displayed).

(28) Depress matrix buttons D-5 (SURVEY).

(29) Depress the SM key.

(30) On the keyboard type 3 and depress the ENTER key (the compute indicator lights momentarily) and the following 02 orienting data are displayed:

Azimuth 6397, Distance 4014, Vertical angle +4

Note. The orienting data concerning the last observer recalled in the sequence of actions in (22) through (27) above will be displayed first. Step (31) will complete the orientation data computation.

(31) Depress the ENTER key a second time and the 01 orienting data will be displayed:

Azimuth 227, Distance 3845, Vertical angle -3

D-9. Zone-to-Zone Transformation

a. The grid location of an enemy position and the observer-target direction were reported by an observer using a map in UTM grid zone 14S. The fire direction data currently being used in FADAC is referenced in UTM grid zone 15S.

★*b.* The following data are known:

(1) Local grid zone number .... 15S.

(2) Adjacent grid zone number ..... 14S.

(3) Latitude: Northern hemisphere.

(4) Map spheriod: Clarke 1866.

(5) Enemy position: Zone 14S, OP 75243 35474 (the lower left corner coordinates of the OP 100,000 meter square in grid zone 14S is 600 000 38000 000).

(6) Observer—target direction: 540 mils.

(7) Enemy position altitude: 567 meters.

c. Transform the UTM grid zone 14S coordinates to the UTM grid zone 15S data and store the results as the location of target number 4.

d. Data are processed as follows:

(1) Depress matrix buttons E-5 (Zone 1 to Zone 2).

(2) Depress the SM key.

(3) On the keyboard type *1* and depress the ENTER key (keyboard indicator remains lit).

(4) On the keyboard type (+) 14 and depress the ENTER key.

(5) Depress the SM key.

(6) On the keyboard type 2 and depress the ENTER key (keyboard indicator remains lit).

(7) On the keyboard type (+) 15 and depress the ENTER key.

(8) Depress matrix buttons E-6 (STA EAST).

(9) Depress the SM key.

(10) On the keyboard type 675243 and depress the ENTER key.

(11) Depress matrix buttons E-7 (STA NORTH).

(12) Depress the SM key.

(13) On the keyboard type 3835474 and depress the ENTER key.

(14) Depress matrix buttons E-8 (SPHERE/AZ).

(15) Depress the SM key.

(16) On the keyboard type *1* (flag for Clarke 1866 spheroid) and depress the ENTER key (keyboard indicator remains lit).

(17) On the keyboard type 540 and depress the ENTER key.

(18) Depress matrix buttons D-5 (SURVEY).

(19) Depress the SM key.

(20) On the keyboard type 4 and depress the ENTER key (keyboard indicator remains lit).

(21) On the keyboard type *1* (flag *1* indicates the station as a target location and will cause the computer to automatically enter the transposed grid in matrix locations A-1 (TGT EAST) and A-2 (TGT NORTH) and azimuth in A-5 (OT DIR)).

(22) Depress the ENTER key. The following data are displayed:

Transposed grid: 25261 41419
Transposed direction: 601 mils

Note. The target altitude must be obtained from the VCO map and entered.

(23) Depress matrix buttons A-3 (TGT ALT).

(24) Depress the SM key.

(25) On the keyboard type 567 and depress the ENTER key.

(26) Depress matrix buttons A-4 (TGT STORE).

(27) Depress the SM key.

(28) On the keyboard type 4 and depress the ENTER key.

D-10. Derived Muzzle Velocity

a. Battery A received a new lot of HE ammunition Lot R (105-mm), RW (155-mm, 8-inch, 175-mm). A chronograph is unavailable to measure the muzzle velocity data for the new lot of ammunition and since all other parameters are known, the S3 decides to fire a high-burst registration and then derive the developed muzzle velocity.

★*b.* The following battery data are known:

(1) Powder temperature: +38°.

(2) Projectile weight:

105-mm	34.2	lb
155-mm	97.2	lb
8-inch	205.0	lb
175-mm	152.2	lb

(3) Latitude: 34° North.

(4) Grid declination: +8 mils.

(5) Battery (coordinates base piece) 48512 30368 Altitude: 420.

(6) Azimuth laid: 860 mils.

(7) Deflection: use data in paragraph D-3*a*.

(8) Meteorological message:

Introduction

Identification	Octant	Location	Date-Time	Station Height (10's M)	MDP Pressure (mbs)
METCM	1	341981	280310	038	976

BODY

Line number	Wind direction (10's mils)	Wind speed (knots)	Temperature (1/10° K)	Pressure (mbs)
00	080	008	2718	0976
01	110	010	2707	0965
02	100	016	2672	0944
03	162	020	2668	0938
04	110	010	2657	0898
05	322	045	2616	0832
06	398	038	2580	0793
07	520	040	2542	0762
08	544	055	2483	0698
09	570	046	2444	0656
10	580	030	2402	0636
11	620	020	2364	0616
12	650	025	2320	0582
13	448	030	2248	0541
14	496	040	2196	0501
15	530	036	2152	0465
16	525	028	2138	0383
17	421	060	2096	0298
18	451	058	2088	0265
19	480	050	2068	0208
20	500	055	2055	0162

★*c.* Using the set up and end of mission procedures detailed in table 2-1, clear any previously entered muzzle velocity data and enter the known data.

(1) Depress "A" battery button.

(2) Depress matrix buttons E-1 (EOM).

(3) Depress the SM key.

(4) On the keyboard depress 0.

(5) Select the appropriate caliber button.

(6) Depress matrix buttons E-2 (SET UP).

(7) Depress the SET UP button.

(8) Using the same procedures as detailed in paragraph D-3*b* enter the battery data.

(9) Using the same procedures as detailed in paragraph D-6*f* steps (20) through (29) enter the meteorological message.

d. The high-burst registration is fired using the following firing data: (This is the *adjusted data.*)

Weapon type	*Charge*	*Deflection*	*M564 Time*	*Quadrant elevation*
105-mm M101A1	7	2860	40.0	600
105-mm M102, M108	7	3260	38.0	540
155-mm M114A1	7	2460	30.0	360
155-mm M109	7	3260	30.0	360
8-inch M110	6	3260	31.0	420
175-mm M107	1	3260	30.0	370

e. Computed location of the high burst is:

(1) Coordinates of high burst: 55480 37262.

(2) Altitude of high burst: 508 meters.

f. These data are entered and registration corrections computed as follows:

(1) Depress matrix buttons A-1 (TGT EAST).

(2) Depress the SM key.

(3) On the keyboard type 55480 and depress the ENTER key.

(4) Depress matrix buttons A-2 (TGT NORTH).

(5) Depress the SM key.

(6) On the keyboard type 37262 and depress the ENTER key.

(7) Depress matrix buttons A-3 (TGT ALT).

(8) Depress the SM key.

(9) On the keyboard type 508 and depress the ENTER key.

(10) Depress matrix buttons B-1 (CHG).

(11) Depress the SM key.

(12) On the keyboard type (the appropriate charge for the type weapon) and depress the ENTER key.

*(13) Depress matrix buttons B-6 (FUZE TYPE).

*(14) Depress the SM key.

*(15) On the keyboard type 7 and depress the ENTER key.

(16) Depress matrix buttons G-6 (DF INPUT).

(17) Depress the SM key.

(18) On the keyboard type in (the adjusted deflection) and depress the ENTER key.

*(19) Depress matrix buttons G-7 (TIME INPUT).

*(20) Depress the SM key.

*(21) On the keyboard type in (the adjusted time) and depress the ENTER key.

(22) Depress matrix buttons G-8 (QE INPUT).

(23) Depress the SM key.

(24) On the keyboard type in (the adjusted quadrant elevation) and depress the ENTER key.

(25) Depress matrix buttons H-8 (COMP REG) and depress the SM key. The following data is displayed:

Weapon type	*Deflection correction*	*Time correction*	*Range K*
105-mm M101A1	(+) R.5	(−) .2	+12
105-mm M102, M108	(+) R1.1	(−) .4	+20
155-mm M114A1	(−) L.1	(−) .3	+26
155-mm M109	(+) R.4	(+) .4	+22
8-inch M110	(+) R1.7	(−) 1.0	+32
175-mm M107	(−) L2.8	(+) 0	+32

g. The S3 notes that the K is plus which indicates that the developed muzzle velocity of the new lot is less than standard. He directs the FADAC operator to derive the muzzle velocity from the known data.

h. The operator estimates the change in muzzle velocity and applies it to the standard muzzle velocity. He inputs the new muzzle velocity and recomputes the registration corrections. When the computed range K is 0, the input muzzle velocity is correct. Registration corrections are then computed and applied even though the range K will equal zero since the deflection (and time) corrections are valid. In estimating the input muzzle velocities, the change in muzzle velocity for each estimated input may be computed using tabular firing table data as follows:

*Omit steps (13) through (15) and steps (19) through (21) for the 175-mm gun.

(1) Multiply the K by the range to the high burst/1000 to determine the total range correction in meters.

(2) Divide the total range correction by the meters per second value (Column 10, Table F, TFT) to determine the change in muzzle velocity. In this example (using the 105-mm (M102) data from FT 105-AS-1) these calculations are—

Range to high burst = 9800 (Use function D-7)

K = +20

(9.8 x 29)/17.4* = 11.3 m/sec (Change in MV)

*Valves from the TFT are extracted opposite the range corresponding to the adjusted time or time of flight.

(3) Apply this estimated change in muzzle velocity to the muzzle velocity used by the computer and determine a new input muzzle velocity, and recompute the K. A bracketing procedure is ordinarily used until the K is equal to zero.

Note. Using appendix "C" note the standard muzzle velocity for the registration charge.

Weapon type	*Charge*	*Standard MV*
105-mm M101A1	7	464.8
105-mm M102, M108	7	494.0
155-mm M114A1	7	563.9
155-mm M109	7	561.0
8-inch M110	6	499.0
175-mm M107	1	510.5

(4) Continuing the example:

Standard muzzle velocity = 494.0

Correction to MV = −11.3

Estimated MV (1) = 482.7

i. The FADAC operator then enters the new estimated MV.

Note. Different estimates may be used without affecting the final solution.

Weapon type	*Estimated MV (1)*
105-mm M101A1	458.0
105-mm M102, M108	482.7
155-mm M114A1	552.1
155-mm M109	551.0
8-inch M110	487.0
175-mm M107	498.7

(1) Depress matrix buttons G-1 (MV).

(2) Depress the SM key.

(3) On the keyboard type 1X (1 = shell HE, X = charge).

(4) Depress the ENTER key (keyboard indicator remains lit).

(5) On the keyboard type in the estimated MV (1) and depress the ENTER key.

(6) Depress matrix buttons H–8 (COMP REG) and then depress the SM key. The following corrections are displayed:

Weapon type	*Deflection correction*		*Time correction*		*Range K*
105-mm M101A1	(+)	R.5	+	.2	−2
105-mm M102, M108	(+)	R1.3	+	.2	−5
155-mm M114A1	(+)	R.0	+	.2	+0
155-mm M109	(+)	R.3	+	.1	−0
8-inch M110	(+)	R1.9	−	.3	−2
175-mm M107	(−)	L3.0	+	.0	−0

(7) On the keyboard type a period (.) and depress the ENTER key.

j. Again using only 105-mm (M102) data, the K is now negative, therefore the input muzzle velocity, MV (1) was too small. The actions in *h* above are repeated. In this example these calculations are—

Range to high burst =	9800
K =	−5
(9.8 x −5) 17.4 =	2.8 meters/sec
Input MV(1)	482.7
Correction to MV(1)	+2.8
Estimated MV(2) =	485.5

Weapon type	*Estimated MV(2)*
105-mm M101A1	459.1
105-mm M102, M108	485.5
155-mm M114A1	552.0
155-mm M109	551.2
8-inch M110	487.9
175-mm M107	498.9

k. Enter the second muzzle velocity estimated in *j* above and recompute the correction. If the K is 0, the last input muzzle velocity is correct. If a final refinement of data is desired, .2m/sec changes are made until the upper and lower limits of the MV bracket are established. The center of this bracket is the refined derived muzzle velocity.

Weapon type	*Derived MV (+ .2)*
105-mm M101A1	459.2
105-mm M102, M108	485.0
155-mm M114A1	552.0
155-mm M109	551.1
8-inch M110	487.8
175-mm M107	498.8

★*l.* Compute and apply the final registration corrections after the derived muzzle velocity has been entered.

(1) Depress matrix buttons H–8 (COMP REG) and depress the SM key. The COMPUTE indicator lights, then the keyboard indicator lights and the final corrections are displayed:

Weapon type	*Deflection correction*		*Time correction*		*Range K*
105-mm M101A1	(+)	R.5	(−)	.1	0
105-mm M102, M108	(+)	R.12	(+)	.1	0
155-mm M114A1	(−)	L.0	(+)	.2	0
155-mm M109	(+)	R.3	(+)	.1	0
8-inch M110	(+)	R1.9	(−)	.4	0
175-mm M107	(−)	L3.0	(+)	.0	0

(2) On the keyboard type the appropriate charge and depress the ENTER key (keyboard indicator remains lit).

(3) On the keyboard type a period (.) and depress the ENTER key. These corrections are automatically applied for the designated charge and battery.

APPENDIX E
CANNON PROGRAM TAPES

E-1. Revision 4

The following items are contained in Revision 4, Cannon Machine Tape Kit, Federal Stock Number (FSN) 1290-466-0140. The set of addendum tapes is packaged separately and may be requisitioned as a set identified by FSN 1290-466-0142. The basic cannon program tape is packaged separately and may be requisitioned as a separate item identified by FSN 1290-466-0141. The basic cannon program tape incorporates the ballistic data for the 105-mm howitzers M102 and M108 and the 155-mm howitzer M109.

★*Item*	*Part number*
Basic cannon program tape	8213330-80
Addendum tapes:	
105-mm How, M101A1/105-mm How M102, M108	8213315-81
105-mm How M101A1/155-mm How M114A1	8213315-82
105-mm How M101A1/155-mm How M109	8213315-83
105-mm How M102, M108/155-mm How M114A1	8213315-84
105-mm How M102, M108/155-mm How M109	8213315-85
155-mm How M109/155-mm How M114A1	8213315-86
8-inch How M110/155-mm How M114A1	8213315-87
175-mm G, M107/155-mm How M114A1	8213315-88
155-mm M109/8-inch How M110	8213315-89
155-mm M109/175-mm G, M107	8213315-90
8-inch How M110/175-mm G, M107	8213315-91
105-mm How M101A1/8-inch How M110	8213315-92
105-mm How M102, M108/8-inch How M110	8213315-93
105-mm How M101A1/175-mm G, M107	8213315-94
105-mm How M102, M108/175-mm G, M107	8213315-95
Clear hot storage tape	8213315-96
Repetitive test routine	8213315-97
Mechanical tape reader	8213315-98

★ E-2. Revision 5

The Revision 5 cannon program is configured as a series of program tape cartridge assemblies and an accessory kit. Each program tape contains the data base for only one model of weapon. Nine separate cartridge assemblies are available. See *a* below. A tape is included in the cartridge assembly package. The accessory kit contains the required matrix windows, diagnostic tapes, flag cards, and operators' manuals. See *b* below.

a. Cartridge, Assemblies, Revision 5. (1 tape per cartridge assembly.)

FOR CALIBER/MODEL	NSN	PART NO.	COST
105-mm H, M101A1	1290-00-229-4722	8213330-109	94.72
105-mm H, M102	1290-00-229-4723	8213330-110	157.00
155-mm H, M114A1	1290-00-229-4724	8213330-111	94.72
155-mm H, M109	1290-00-229-4731	8213330-112	129.00
155-mm H, M109A1	1290-00-207-9462	8213330-113A	171.00
8-inch H, M110E1	1290-00-229-4736	8213330-114	91.78
8-inch H, M110E2	1290-00 (Under acceptance test at WSMR)		
175-mm G, M107	1290-00-229-4750	8213330-115	94.72
14.5-mm T, M31	1290-00-275-1700	8213330-118	N/C

b. Kit, Accessory, Revision 5. NSN: 1290-00-148-7757, Part No. 11745025

APPENDIX F

FLAG CARD—8-INCH HOWITZER AND 175-MM GUN

REVISION 4 CANNON PROGRAMS FOR ALL SERIES AND COMBINATIONS

Note. This extract of data applies to programs identified by program test 1, display number 1 00000 00040 08075.

1. SETUP
   Weapon 1 and weapon 2 are identified in the program test 1 display number.

2. MATRIX POSITIONS REQUIRING SIGNED INPUT

A–6 RIGHT/LEFT	F–7 TIME CORP
A–7 ADD/DROP	F–8 RANGE/K
A–8 UP/DOWN	G–2 POWD TEMP
C–7 OBS VERT	G–4 LAT
E–5 ZONE 1 TO ZONE 2	G–5 GRID DECL
F–6 DF CORR	

3. MATRIX POSITIONS USING ENABLE PROCEDURE
   (O–ENTER, 9–DISMISS)

B–2 HIGH ANGLE	D–6 TEMP MSN STORE
B–3 WHITE CHG 3, 4, 5	E–1 EOM
B–4 GT LINE ADJ	H–6 MET STD
D–1 CHRONOGRAPH	H–7 ZERO CORR

4. ERROR DISPLAYS

X 0	—Out of range for X-charge.
. . . . 1	—Battery button changed during computation.
. . . . 2	—Illegal shell-fuze combination.
. . . . 3	—No OT azimuth entered.
. . . . 4	—Illegal charge.
. . . . 5	—Survey entry or procedural error.
. . . . 6	—No target entered prior to computation.
. . . . 7	—No charge entered prior to using COMP REG.
X 8	—Target on ascending trajectory.
. . . . 9	—Attempt to enter more than two decimals.
. . . 10	—Attempt to store negative altitude.
. . . 24	—Use of cannon or chronograph program while in the opposite mode.
NSL (no solution light) with display of gun data	—Intended impact point is in no-fire area, or maximum elevation exceeded.

5. SURVEY FLAGS
   1 TRAVERSE
   2 INTERSECTION
   3 ORIENTATION
   4 ZONE-TO-ZONE

6. FLAGS
   a. MODE flag. Use with chronograph (D–1). (9–BALLISTIC, 0–CHRONOGRAPH)
   b. CHARGE flag. Corresponds to charge number. Used for CHG (B–1), MV (G–1), and COMP REG (H–8).
   c. MUZZLE VELOCITY flag. Two-digit number. First digit, PROJ TYPE flag; second digit, CHG flag used with MV (G–1).
   d. Percent DENSITY/DELAY flag. Use with % DENSITY/DELAY (D–2) (1–% DENSITY, 2–DELAY).

e. MASS FIRES flag. Use with MASS FIRES (D-8).

Battery	*Flag*
A	1
B	2
C	3
D	4
E	5

f. PROJECTILE TYPE flags. Used for PROJ TYPE (B-5), PROJ WT (G-3), and MV (G-1).

Type	*Model*	*Standard weight*	*Flag*
		8-INCH HOWITZER	
HE	M106	200.0	1
--	--	--	-
--	--	--	-
HES	M424	242.0	4
AE	M422	242.0	5
HE	M404	201.0	6
--	--	--	-
--	--	--	-
GAS	M426	200.0	9
		175-MM GUN	
HE	M427 MODS	147.8	1

g. FUZE flags. Use for FUZE TYPE (B-6).

Model	*Type*	*Flag*
M51 Series, M508 Series, M535, M557, M78*, M572	Q	1
M500A1, M520 Series	TI	2
M514*, M514 Series	VT	3
—	-	-
M542, M543	MT	5**
—	-	-
M564 Series, M565 Series, M548	TI	7

* Requires correction to projectile weight.
** Use with projectile flags 4 and 5 only.

FLAG CARD—105-MM AND 15-MM HOWITZERS
REVISION 4 CANNON PROGRAMS ALL SERIES AND COMBINATIONS

★*Note.* This extract of data applies to programs identified by program test 1, display number 1 00000 00040 05155.

1. SETUP
   Weapon 1 and weapon 2 are identified in the program test 1 display number.

2. MATRIX POSITIONS REQUIRING SIGNED INPUT

A-6 RIGHT/LEFT	F-7 TIME CORR
A-7 ADD/DROP	F-8 RANGE/K
A-8 UP/DOWN	G-2 POWD TEMP
C-7 OBS VERT	G-4 LAT
E-5 ZONE 1 TO ZONE 2	G-5 GRID DECL
F-6 DF CORR	

3. MATRIX POSITIONS USING ENABLE PROCEDURE
   (0-ENTER, 9-DISMISS)

B-2 HIGH ANGLE	D-6 TEMP MSN STORE
B-3 WHITE CHG 3, 4, 5	E-1 EOM
B-4 GT LINE ADJ	H-6 MET STD
D-1 CHRONOGRAPH	H-7 ZERO CORR

4. ERROR DISPLAYS
   X.... ......0—Out of range for X-charge.
   ....1—Battery button changed during computation.
   ....2—Illegal shell-fuze combination.
   ....3—No OT azimuth entered.
   ....4—Illegal charge.
   ....5—Survey entry or precedural error.
   ....6—No target entered prior to computation.
   ....7—No charge entered prior to using COMP REG.
   X ......8—Target on ascending trajectory.
   ....9—Attempt to enter more than two decimals.
   ....10—Attempt to store negative altitude.
   ....24—Use of cannon or chronograph program while in the opposite mode.
   NSL (no solution light) with display of gun data —Intended impact point is in no-fire area or maximum elevation exceeded.

5. SURVEY FLAGS
   1 TRAVERSE
   2 INTERSECTION
   3 ORIENTATION
   4 ZONE-TO-ZONE

6. FLAGS
   a. MODE flag. Use with chronograph (D-1) as follows: (9—BALLISTIC, 0—CHRONOGRAPH).
   b. CHARGE flags. Same as charge number (1-7), used for CHG (B-1), MV (G-1), COMP REG (H-8).
   c. MUZZLE VELOCITY. Identity flag. Two digit number. First digit = PROJ TYPE flag; 2nd digit = CHARGE flag used with MV (G-1).
   d. PERCENT DENSITY/DELAY flag. Use with % DENSITY/DELAY (D-2) as follows: 1-% DENSITY, 2-DELAY.

e. MASS FIRES flag. Use with MASS FIRES (B-8).

Battery	*Flag*
A	1
B	2
C	3
D	4
E	5

f. PROJECTILE TYPE flags. Used for PROJ TYPE (B-5), PROJ WT (G-3), and MV (G-1).

Type	*Model*	*Standard weight*	*Flag*
		105-MM PROJECTILES	
HE	M1	33.0	1
WP	M60	34.8	2*
SMK	M84	32.9 (HC)	3*
ILLUM	M314A2E1	35.0	4
---	---	---	--
HE	M444	33.0	6
CS	XM629	33.6	7
---	---	---	--
GAS	M360	35.4	9*
		115-MM PROJECTILES	
HE	M107	95.0	1
WP	M110	97.2	2*
SMK	M116	86.4 (COLOR)	3*
ILLUM	M485	90.0	4
AE	M454	120.5	5
HE	M449	95.5	6
HE	M449A1 (E2)	95.7	7
HE	M449E1	97.0	8
GAS	M121	99.4	9*

g. FUZE flags. Used for FUZE TYPE (B-6).

Model	*Type*	*Flag*
M51 Series, M508 Series, M557, M78**	Q	1
M501, M520, M500A1	TI	2
M513*, M513 Series, M514*, M514 Series, T361E2	VT	3
—	—	—
M32E1	SPEC	5***
M564, M565, M548	TI	7

*Enter nominal weights for colored smoke, H-M60 or HD-M60, or H-M110, or HD-M110 dependent on filler. See appendix C.

**Wt correction to proj wt required.

***Use with projectile flag 5 only.

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General, United States Army,
Chief of Staff.

Official:

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The Adjutant General.

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★APPENDIX G
FADAC REVISION 5 BASIC PROGRAM CONTROL

G-1. General

This appendix contains guidance for use of the Revision 5 Cannon Application Program. Procedures that are common to Revision 4 program are referenced to appropriate paragraph.

G-2. The Control Panel

a. The operator controls described in paragraphs 2-8 through 2-12 for the Revision 4 program are the same for the Revision 5 program except for the numbered buttons, 1 and 2. In the Revision 5 program, these two buttons are used to designate which input selection matrix overlay is being used. Matrix overlay number 1 (fig G-1) is used when matrix selector button number 1 is depressed; matrix overlay number 2 (fig G-2) is used when matrix selector button number 2 is depressed.

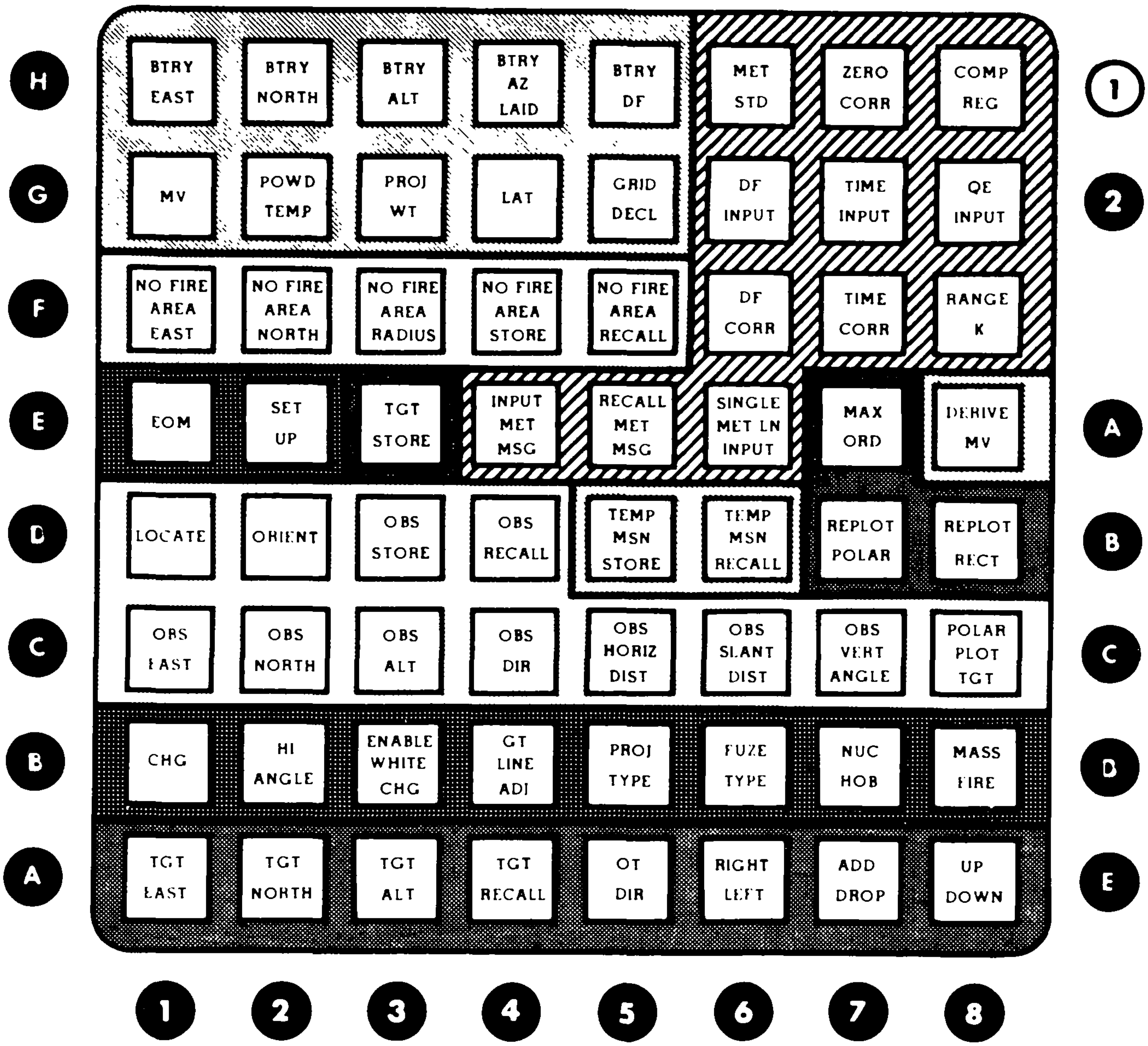

Figure G-1. Matrix overlay.

b. Matrix overlay 1 is used to control the input or recall of data or the solution of the gunnery problem. Matrix overlay 2 is used to control the input or recall of data or the solution of problems related to survey or the chronograph. Observer orientation, high-burst or mean-point-of-impact location by intersection, and polar plot (coordinates from azimuth and distance) are survey routines associated with the gunnery problem. Therefore, matrix overlay 1 also controls these three routines.

c. Matrix overlay 2 may be used to solve four types of survey problems—trilateration, traverse, azimuth by altitude, and zone-to-zone transformation.

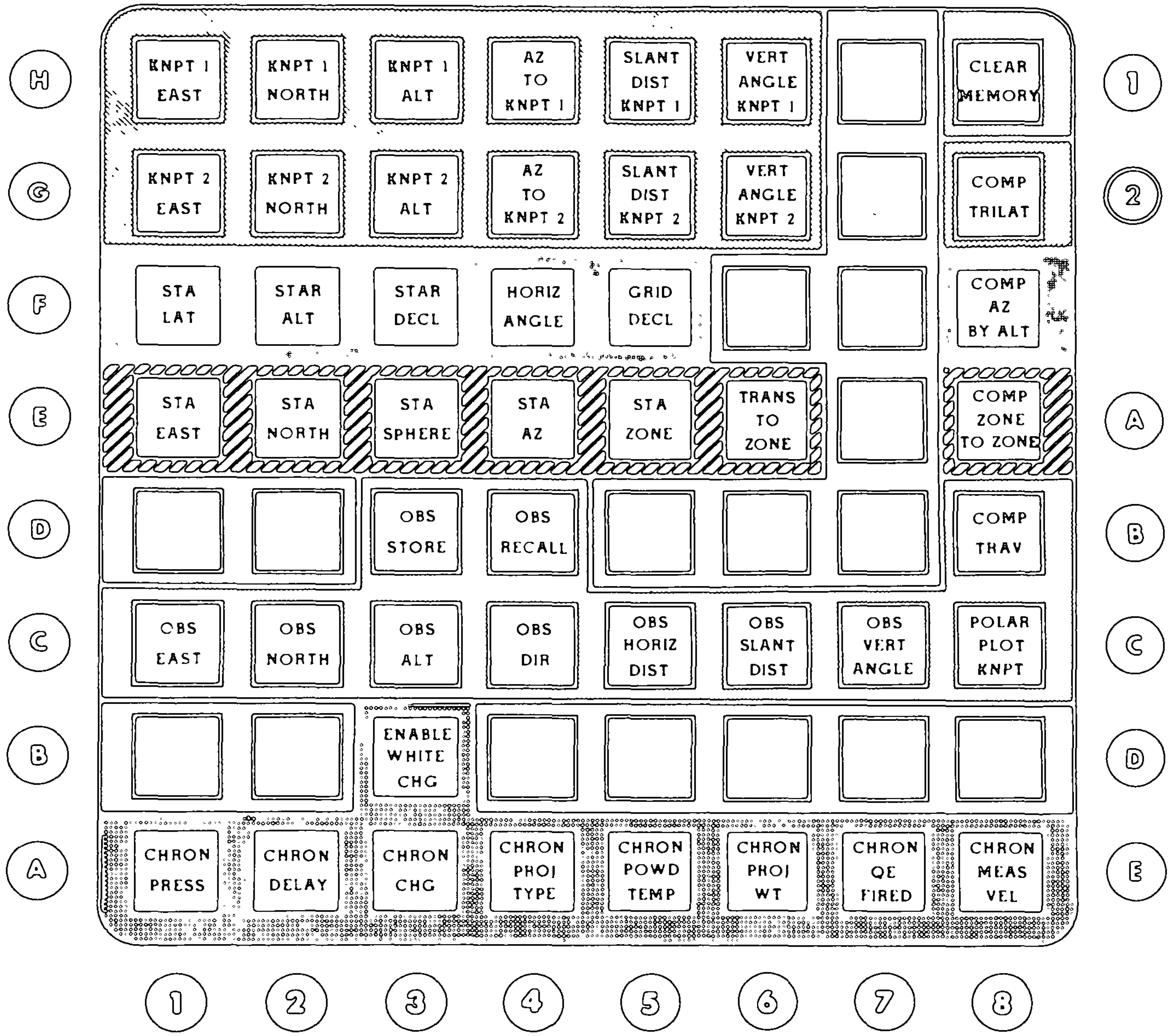

Figure G-2. Matrix overlay 2.

G-3. Program Tests

a. For program test 1, refer to paragraph 2-14.

b. For program test 2, refer to paragraph 2-14. If the program test 2 is unsuccessful, the operator must clear the indicated channel by using the procedure described in table G-17 for matrix 2 function H-8 (CLEAR MEMORY). After the channel has been cleared and a valid program test 2 has been completed, the operator should study the memory map (fig G-3) to determine what data must be reentered. When the correct data for that channel have been reentered, the test should be repeated.

CHANNEL NUMBER	DATA STORED IN MEMORY	ENTER DATA IN FUNCTIONS- - ON MATRIX 1	ENTER DATA IN FUNCTIONS- - ON MATRIX 2
70	Meteorological message	E-4	
	Adjusted deflection	°G-6	
	Chronograph extrapolation data		A-1 through A-8
	Azimuth-by-altitude data		F-1 through F-5
72	No-fire-area coordinates	F-1 through F-3	
	Observer data	C-1 through C-7	C-1 through C-7
	Meteorological message	E-4	
	Met standard and mass fire flags	°B-8 and H-6	
	Latitude and adjusted QE	G-4 and °G-8	
	Observer list (18 entries)	D-3	D-3
	Zone-to-zone azimuth		E-4
74	Adjusted time	°G-7	
	Zone-to-zone data		E-2, E-3 and E-5
76	Zone-to-zone data		E-1 and E-6
	Known point data		G-1 through G-6
	Known point data		H-1 through H-6
	Grid declination	G-5	
110	No-fire-area list (42 entries)	F-1 through F-4	
112	Target list (128 entries)	°E-3	
114	Target list (128 entries)	°E-3	
116	Battery D: Grid, altitude deflection, azimuth laid nonstandard projectile weights, muzzle velocity, and powder temperature	°E-2 °G-1 through °G-3 °H-1 through °H-5	
130	Battery E		
132	Battery B		
134	Battery A		
136	Battery C		

°Battery associated data; appropriate battery selector button must be depressed

Figure G-3. Memory map.

c. For program test 3, (Display TEST), refer to paragraph 2-16.

G-4. Setup

a. The computer program uses the SET UP button and matrix 1 function E-2 (SET UP) to establish standard values in the *battery memory channel* depending on which battery selector button has been depressed and to reset other temporary data to zero, to minus zero, or to a standard default value. The data that are reset to zero are the battery grid, altitude, azimuth of lay, and deflection. Powder temperature, projectile weight, and muzzle velocity values are set to the standard values presented in paragraph G-5. All battery-associated values and flags that were stored by the use of matrix 1 are returned to zero, to minus zero, or to the standard default value. The data that are not affected by the setup procedure are the target, observer, and no-fire area lists; the latitude; the grid declination; and the met standard flag and entered meteorological message. Since setup is a matrix 1 function, values entered with matrix 2 are not affected.

b. When the computer is first programed, each battery selector button must be depressed in turn and the setup procedure must be completed before battery-associated missions can be solved. The ability to clear the selected data from the working part of the memory by means of the setup procedure is convenient when a battery occupies a new position. The setup procedure insures that outdated ballistic parameters, particularly muzzle velocity and projectile weight data, will not inadvertently be used for current problems. Separate procedures permit the clearing of target, observer, and no-fire area lists. (See paragraph G-5b.)

G-5. Standard Values

a. General. The computer program automatically selects and uses the lowest practical propellant charge unless the operator designates a specific charge. The program also selects high-explosive shell and fuze quick unless the operator enters a specific flag designating a particular shell or fuze. Standard muzzle velocity, projectile weight, and propellant temperature are used unless the operator enters known nonstandard values.

b. Zero and minus zero. The program automatically resets most functions to zero or minus zero during computations. In the computer program a minus zero is zero preceded by a minus sign. When a function has been reset to minus zero, the computer program will demand an entry for that function in subsequent computations. This technique is a safety feature designed to avoid errors caused by the failure of the operator to enter complete data for a problem solution. For example, function E-1 (EOM) resets all target data to minus zero; then, if the operator neglects to enter the complete target data in a new mission, the computer program cannot use the minus zero value as part of the target data and will warn the operator by causing the NO SOLUTION indicator to flash and by displaying a----06 error flag. The entire target list (128 targets), observer list (18 observers), and no-fire area list (42 no-fire areas) are set to zero by the manual entry of 0.0 in the appropriate store function.

c. Standard met. The standard meteorological data used in the program are presented in table G-1. Standard values for wind direction and velocity are zero and therefore are not shown. The values for temperature and pressure that are listed in table G-1 are the mean values within the zone.

Table G-1. Standard Temperatures and Pressures

ZONE HEIGHT	LINE NO.	TEMP	PRESS	ZONE HEIGHT	LINE NO.	TEMP	PRESS
(Meters)		(1/10°K)	(mb)	(Meters)		(1/10°K)	(mb)
Surface	00	2,882	1,013				
200	01	2,875	1,001	8,000	14	2,395	0,383
500	02	2,859	0,972	9,000	15	2,330	0,332
1,000	03	2,833	0,926	10,000	16	2,265	0,286
1,500	04	2,800	0,872	11,000	17	2,200	0,245
2,000	05	2,768	0,820	12,000	18	2,167	0,210
2,500	06	2,735	0,771	13,000	19	2,167	0,179
3,000	07	2,703	0,724	14,000	20	2,167	0,153
3,500	08	2,670	0,679	15,000	21	2,167	0,131
4,000	09	2,638	0,637	16,000	22	2,167	0,112
4,500	10	2,605	0,597	17,000	23	2,167	0,096
5,000	11	2,573	0,559	18,000	24	2,167	0,082
6,000	12	2,524	0,505	19,000	25	2,167	0,070
7,000	13	2,459	0,441	20,000	26	2,167	0,060

d. Standard projectile weights and projectile-fuze combinations. The standard projectile weights used in the program are shown for all calibers in tables G-2 through G-5 below. The tables also indicate the legal, compatible projectile-fuze combinations by solid black squares in the fuze columns opposite the projectile type. Weights are indicated to the nearest 0.1 pound. Because of the methods used to store data in memory, a recalled value may be slightly different from an entered value. This difference will in no way affect the accuracy.

Table G-2. Standard Projectile Weights and Projectile-Fuze Combinations for 105-mm Howitzers M101A1, M102, and M108

PROJECTILES					FUZES											
					FLAGS											
					1				2		3		7			8
					PD				TI		VT		TI			VT
			STANDARD													
FLAG	TYPE	MODEL	WEIGHT POUNDS	SQUARES	M51	M78	M508	M557	M501	M520	M513 MODS	M728	M548	M564 M582	M565	M513 CAPPED
1	HE	M1	33.0	2	■	■		■		■	■	■		■		■
2	WP	M60	34.8	5	■		■	■						■		
2	GAS H, HD	M60	33.0*	2	■		■	■						■		
3	HC SMK	M84	32.9						■							
4	ILLUM	M314	32.7										■		■	
6	HE (ICM)	M444	33.0	2									■		■	
7	CS	XM629	33.6	3									■		■	
9	GAS GB, VX	M360	35.4	6			■									
11	HE (RA)-ON	M548	27.4*					■				■		■		
0	HE (RA)-OFF	M548	28.5					■				■		■		

*Enter this weight manually.
NOTE: The M513 series VT fuzes may not be fired with Charge 7.

Table G-3. Standard Projectile Weights and Projectile-Fuze Combinations for 155-mm Howitzers M114A1, M109, and M109A1

PROJECTILES					FUZES													
					FLAGS													
					1				2		3			5	7			
					PD				TI		VT			TI	TI			
			STANDARD															
FLAG	TYPE	MODEL	WEIGHT POUNDS	SQUARES	M51	M78	M508	M557	M501	M520	M514	M728	T 361E1	XM32 E1	M548	M564 M582	M565	M577
1	HE	M107	95.0	4	■	■		■		■	■	■				■		
2	WP	M110	97.2	6	■			■		■						■		
2	GAS H, HD	M110	*95.0	4	■			■		■						■		
3	HC SMK	M116	86.4						■									
4	ILLUM	M485	91.5												■		■	■
5	AE	M454	120.5										■	■				
6	HE (ICM)	M449	95.5	4											■		■	■
7	HE (ICM)	M449A1 (E2)	95.7	4											■		■	■
8	HE (ICM)	M449 E1	97.0	6											■		■	■
9	GAS GB, VX	M121A1	99.4	8			■	■			■	■						
10	HE (ICM)	M483	102.7	4														■
11	HE-RA, ON	M549	*89.1	4				■			■	■						
0	HE-RA, OFF	M549	96.0	4				■			■	■				■		

*Enter this weight manually.
NOTE: The Revision 5 program will not compute data for the HE (ICM) projectile M483 or the HE (RA) projectile M549 for howitzers M114A1 and M109A1.

Table G-4. Standard Projectile Weights and Projectile-Fuze Combinations for 8-inch Howitzers M110 and M110E1

PROJECTILES					FUZES												
					FLAGS												
					1				2	3			5	7			
					PD				TI	VT			TI	TI			
			STANDARD														
FLAG	TYPE	MODEL	WEIGHT POUNDS	SQUARES	M51	M78	M508	M557	M520	M514	M728	M542	M543, M591	M564 M582	M565	M577	M548
1	HE	M106	200.0	4	■	■		■	■	■	■			■			
4	HES	M424	242.0										■				
5	AE	M422	242.0									■					
6	HE (ICM)	M404	201.0	4											■		■
9	GAS GB, VX	M426	200.0	4			■			■	■						
10	HE (ICM)	XM509	206.3	4												■	

Table G-5. Standard Projectile Weights and Projectile-Fuze Combinations for 175-mm Guns M107 and M107E1

PROJECTILES					FUZES		
					FLAGS		
					1	3	
					PD	VT	
			STANDARD				
FLAG	TYPE	MODEL	WEIGHT POUNDS	SQUARES	M572	M728	M514
1	HE	M437	147.8	3	■	■	■

NOTE: The variance in the weight of a projectile from standard is normally indicated by small squares printed on the projectile. If the projectile is of standard weight a specific number of squares, depending on the type of projectile, are used to indicate the projectile weight is standard. Each square represents a weight zone depending on the caliber. A weight difference of one square indicates a difference in weight from standard of one weight zone. The value of one weight zone is 0.6 pound for 105-mm projectiles, 1.1 pounds for the 155-mm and 175-mm projectiles, and 2.5 pounds for the 8-inch projectiles.

Table G-6. Standard Muzzle Velocity Values for the 105-mm Howitzer M101A1

Flag	Projectile		Charges						
	Type	Model	1	2	3	4	5	6	7
1	HE	M1	195.1	211.8	233.2	262.1	301.8	365.8	464.8
2	WP, H, HD	M60	195.1	211.8	233.2	262.1	301.8	365.8	464.8
3	SMOKE	M84	195.1	211.8	233.2	262.1	301.8	365.8	464.8
9	GAS	M360	195.1	211.8	233.2	262.1	301.8	365.8	464.8
4	ILLUM	M314	185.7	205.0	227.7	256.6	297.1	360.8	453.1
6	HE (ICM)	M444	196.5	212.5	232.9	260.8	299.1	361.7	459.5
7	CS	XM629	191.3	207.9	226.2	251.5	289.6	349.8	441.0
0,11	HE (RAP)	M548	120.1	147.5	182.9	230.1	289.6	402.3	515.1

Table G-7. Standard Muzzle Velocity Values for the 105-mm Howitzers M102 and M108

Flag	Projectile		Charges						
	Type	Model	1	2	3	4	5	6	7
1	HE	M1	205.3	223.4	246.9	277.9	325.1	392.8	493.7
2	WP, H, HD	M60	205.3	223.4	246.9	277.9	325.1	392.8	493.7
3	SMOKE	M84	205.3	223.4	246.9	277.9	325.1	392.8	493.7
9	GAS	M360	205.3	223.4	246.9	277.9	325.1	392.8	493.7
6	HE (ICM)	M444	206.5	223.7	246.7	276.6	322.1	388.6	488.4
4	ILLUM	M314	195.8	213.8	239.0	272.6	317.3	382.6	480.7
7	CS	XM629	190.8	212.1	236.4	267.9	314.5	380.4	475.8
0,11	HE (RAP)	M548	128.0	157.0	195.1	245.1	307.8	429.2	548.6

e. Standard muzzle velocities. The standard muzzle velocity values used in the revision 5 program are shown in tables G-8 through G-14.

Table G-8. Standard Muzzle Velocity Values for the 155-mm Howitzer M114A1

Flag	Projectile		Green bag charges					White bag charges				
	Type	Model	1	2	3	4	5	3	4	5	6	7
1	HE	M107	207.3	234.7	274.3	317.0	374.9	274.3	317.0	374.9	463.3	563.9
2	WP, H, HD	M110	207.3	234.7	274.3	317.0	374.9	274.3	317.0	374.9	463.3	563.9
3	SMOKE	M116	207.3	234.7	274.3	317.0	374.9	274.3	317.0	374.9	463.3	563.9
9	GAS	M121	207.3	234.7	274.3	317.0	374.9	274.3	317.0	374.9	463.3	563.9
4	ILLUM	M485	211.4	239.1	282.5	324.7	385.6	275.0	320.7	380.0	473.6	576.5
6	HE (ICM)	M449	202.1	228.0	272.2	313.2	372.5	274.3	317.6	377.1	466.9	565.6
7	HE (ICM)	M449A1, E2	201.5	227.5	271.7	312.9	372.6	273.3	316.9	376.9	467.3	566.5
8	HE (ICM)	M449E1	202.1	227.5	271.1	311.5	369.8	272.5	315.4	374.1	462.8	560.0
5	AE	M454	310.9	374.9	555.2	NOT APPLICABLE						

Table G-9. Standard Muzzle Velocity Values for the 155-mm Howitzer M109

Flag	Projectile		Green bag charges					White bag charges				
	Type	Model	1	2	3	4	5	3	4	5	6	7
1	HE	M107	207.3	236.2	275.8	317.0	374.9	269.7	313.9	373.4	461.8	562.4
2	WP, H, HD	M110	207.3	236.2	275.8	317.0	374.9	269.7	313.9	373.4	461.8	562.4
3	SMOKE	M116	207.3	236.2	275.8	317.0	374.9	269.7	313.9	373.4	461.8	562.4
9	GAS	M121A1	207.3	236.2	275.8	317.0	374.9	269.7	313.9	373.4	461.8	562.4
4	ILLUM	M485	211.4	239.1	282.5	324.7	385.6	275.0	320.7	380.0	473.6	576.5
6	HE (ICM)	M449	209.9	235.0	278.1	315.9	375.4	280.4	320.3	380.0	465.1	559.9
7	HE (ICM)	M449A1, E2	207.2	232.8	276.6	315.0	375.7	279.0	319.6	380.3	467.0	563.6
8	HE (ICM)	M449E1	207.8	232.8	275.9	313.6	372.9	278.2	318.0	377.5	462.5	557.1
10	HE	M483	197.6	223.4	263.1	303.9	358.6	269.5	308.0	365.3	447.5	542.3
5	AE	M454	310.9	374.9	550.6	NOT APPLICABLE						
0,11	HE (RAP)	M549	208.8	236.2	274.3	NA	370.3	266.7	NA	370.3	461.8	560.8

Table G-10. Standard Muzzle Velocity Values for the 155-mm Howitzer M109A1

	Projectile		Green bag charges					White bag charges					
Flag	Type	Model	1	2	3	4	5	3	4	5	6	7	8
1	HE	M107	211.8	237.7	277.4	318.5	374.9	292.6	336.8	393.2	475.5	565.4	684.3
2	WP	M110	211.8	237.7	277.4	318.5	374.9	292.6	336.8	393.2	475.5	565.4	684.3
3	SMOKE	M116	211.8	237.7	277.4	318.5	374.9	292.6	336.8	393.2	475.5	565.4	684.3
9	GAS	M121A1	211.8	237.7	277.4	318.5	374.9	292.6	336.8	393.2	475.5	565.4	684.3
4	ILLUM	M485	213.6	240.3	281.0	323.3	381.7	309.8	353.2	408.4	488.9	576.5	696.7
6	HE (ICM)	M449	212.2	238.1	277.7	318.2	373.4	298.3	341.0	395.7	475.7	563.1	680.2
7	HE (ICM)	M449A1	209.5	235.9	276.2	317.3	373.7	296.9	340.3	396.0	477.6	566.8	686.4
8	HE (ICM)	M449E1	210.1	235.9	275.5	315.9	370.9	296.1	338.7	393.2	473.1	560.3	677.3
5	AE	M454	313.3	374.9	550.6	NOT APPLICABLE							

Table G-11. Standard Muzzle Velocity Values for the 8-inch Howitzers M110 and M110E1

	Projectile		Green bag charges					White bag charges		
Flag	Type	Model	1	2	3	4	5	5	6	7
1	HE	M106	249.9	274.3	304.8	350.5	420.6	420.6	499.9	594.4
4	HES	M424	254.5	359.7	547.1	NOT APPLICABLE				
5	AE	M422	251.6	356.5	543.9	NOT APPLICABLE				
6	HE (ICM)	M404	249.9	274.3	304.8	349.3	418.2	418.2	497.1	591.3
10	HE (ICM)	XM509	241.6	265.5	295.4	338.7	407.3	416.8	492.0	581.0
9	GAS	M426	249.9	274.3	304.8	350.5	420.6	420.6	499.9	594.4

Table G-12. Standard Muzzle Velocity Values for the 175-mm Guns M107 and M107E1

	Projectile		Charges *		
Flag	Type	Model	1	2	3
1	HE	M437	510.5	704.1	914.4

NOTE: When firing charge 3, propellant charge M86A1 or M86A2 with the additive jacket M1, use a correction of -2 meters per second in muzzle velocity.

***Propellant XM124, M86A1, and M86A2.**

G-6. No Solution Display Codes

a. NO SOLUTION indicator displays. Whenever an erroneous procedure is used, when the number entered in the computer is greater or smaller than the limits allow, or when the input data produce an invalid solution, the NO SOLUTION indicator will flash and in most instances a two-digit number code will be displayed in the display panel to identify the cause. The display code numbers and their meanings are presented in table G-13 below.

Table G-13. NO SOLUTION Displays, Descriptions of Errors, and Corrective Actions

Display	Description of error	Corrective Action
. . . 00	Out of range.	Enter the next higher charge in matrix 1 function B-1 (CHG).
. . . 01	Battery selector button changed during computations.	Reselect the correct battery selector button and depress the COMPUTE button.
. . . 02	Improper projectile-fuze combination or no entry of nuclear height of burst.	Recall the data entered in matrix 1 functions B-5 (PROJ TYPE), B-6 (FUZE TYPE), and B-7 (NUC HOB) to determine which data are in error, and then enter corrected data.
. . . 03	No azimuth entered.	Enter data in matrix 1 function A-5 (OT DIR) or, if appropriate, enter 0 in matrix 1 function B-4 (GT LINE ADJ).
. . . 04	Improper charge.	Enter data to correct the erroneous charge entry in function B-1 (CHG) (matrix 1), or A-3 (CHRON CHG) (matrix 2), or B-3 (ENABLE WHITE CHG) matrix 1 or 2.
. . . 05	Procedural error in survey solution.	Recall the inputs to determine which flags or data were not entered or were entered in error, and then enter correct data. (Consult table 21 or 22 for proper procedure.)
. . . 06	No target entered.	Enter or recall target data.
. . . 07	No registration charge entered.	Enter charge in matrix 1 function B-1 (CHG).
. . . 08	Target before peak of trajectory.	Enter the next lower charge in matrix 1 function B-1 (CHG), or use high-angle fire.
. . . 09	Improper entry.	Reenter data with no more than two digits after the decimal point.

Table G-13. NO SOLUTION Displays, Descriptions of Errors, and Corrective Actions—Continued

Display	Description of error	Corrective action
. . . 11	Met standard enabled.	Enter 9 in matrix 1 function H-6 (MET STD).
. . . 12	Not recallable.	Do not use recall procedure.
. . . 13	Improper matrix button or unused button depressed.	Depress the applicable matrix button.
. . . 14	Invalid solution.	Correct erroneous input data.

b. NO SOLUTION indicator, no display. If the NO SOLUTION indicator flashes but no number code is displayed, the cause is probably the result of the operator's failure to depress at least one battery selector button or one of the two required matrix location selection buttons. Whenever the NO SOLUTION indicator flashes and the computer display panel displays firing data, the intended point of impact is in a no-fire area.

G-7. Flags

a. Charge flags. The flag designating the charge is the same as the charge number. The following matrix functions require a charge flag entry:

Matrix overlay 1

B-1 (CHG)

F-6 (DF CORR)

F-7 (TIME CORR)

F-8 (RANGE K)

G-1 (MV)

H-8 (COMP REG)

Matrix overlay 2

A-3 (CHRON CHG)

b. Mass fire flags. Matrix 1 function B-8 (MASS FIRE) requires a flag entry to designate the batteries to be massed.

Battery	***Flag***
A	1
B	2
C	3
D	4
E	5

c. Projectile and fuze flags. Projectile and fuze flags are shown in tables 4 through 7. Matrix 1 function B-6 (FUZE TYPE) requires a fuze flag entry. The following matrix locations require a projectile flag entry:

Matrix overlay 1

B-5 (PROJ TYPE)

G-1 (MV)

G-3 (PROJ WT)

Matrix overlay 2

A-4 (CHRON PROJ TYPE)

d. Enabling flags. The entry of 0 enables the function and the entry of 9 dismisses the function. The following matrix functions require enabling entries:

Matrix overlay 1	*Matrix overlay 2*
B-2 (HI ANGLE)	B-3 (ENABLE WHITE CHG)
B-3 (ENABLE WHITE CHG)	
B-4 (GT LINE ADJ)	
D-5 (TEMP MSN STORE)	
D-6 (TEMP MSN RECALL)	
E-1 (EOM)	
H-6 (MET STD)	
H-7 (ZERO CORR)	

G-8. The Target List Tape

a. Target lists may be prepared on tape for automatic entry into FADAC. A maximum of 128 targets can be entered on the list; however, any number less than the maximum may be entered. The targets are stored in memory in the same sequence as that in which they are punched on the tape. Tapes may be prepared as outlined in *b* and *c* below.

b. The procedure for preparing a target list tape is as follows:

(1) Advance the tape 4 to 5 inches by using the tape advance lever on the TT-76.

(2) Cut the target list starting with the target to be located in memory as target number 1. Use 15 digits for each data line; use only one carriage return and one line feed at the end of each line. The 15 digits are allocated as follows: five digits for easting, five digits for northing, and five digits for altitude. The significant digits for altitude are always preceded by zeros to fill the five-digit field.

(3) Cut the remaining targets in the sequence in which they are to be stored in memory in the same manner as the first target.

(4) After cutting the last line of the target list, cut the digit 9. (The digit 9 is a stop instruction.)

(5) Advance the tape 4 or 5 inches by using the BLANK key on the TT-76 teletypewriter.

c. The tape preparation is illustrated in tabular form in table G-14.

Table G-14. Target List Tape Preparation

Target list parts	Target list text	Machine functions	Remarks
		Advance the tape 4 or 5 inches by using the BLANK key of the TT-76 teletypewriter.	Use the blank section of tape to thread the tape into the mechanical tape reader.
	Fifteen digits are used for each line: five for easting five for northing five for altitude		Cut the list sequentially starting with target 1.
Target number 1 Target number 2 Target number 3 Remainder of list	432005430000410 381125398700409 400505160000400 * * * *	1 CR, 1 LF 1 CR, 1 LF 1 CR, 1 LF * * * * *	The carriage return code causes the computer to store the 15 digits preceding the code.
	9		The digit 9 is a stop instruction.
		Using the BLANK key on the TT-76 teletypewriter advance the tape 4 or 5 inches.	

G-9. Common Mistakes and Malpractices

Refer to table G-15 below.

Table G-15. Common Mistakes and Malpractices

Description	Result	Preventive and corrective actions
Failure to end the mission	Mission override flags entered in matrix row B locations and the target grid and altitude data will remain in effect for a subsequent mission.	Insure that 0 is entered in matrix 1 function E-1 (EOM) at the end of each fire mission.

Table G-15. Common Mistakes and Malpractices—Continued

Description	Result	Preventive and corrective actions
Incorrect entry of observer's corrections resulting from the transposition of numbers or depression of the wrong key	The displayed gun data will be in error if the incorrect data are used.	Verify the displayed entry before depressing the ENTER key. If the error is detected after the computer has been placed in the compute mode, the operator must enter and compute an equal and opposite correction when the mode terminates to (in effect) cancel the erroneously computed data. He can then make the correct entry.
Depressing the wrong battery selector button	A solution for the wrong battery will result or data will be entered for the wrong battery and thus the previously entered data for that battery will be erased.	Verify the battery button selected by observing the display panel.
Depressing the wrong matrix function buttons or the wrong matrix selection button	Entry or recall of erroneous data may occur.	In many instances, this mistake will be detected by the computer and the NO SOLUTION indicator will flash. Close supervision of all operator procedures will preclude this mistake.
Failure to cancel the gun-target line adjust override when an observer-target line adjustment is desired	Even though an entry is made in function A-5 (OT DIR), the FADAC will continue to use the GT line for computation of data.	Enter 9 in matrix function B-4 (GT LINE ADJ) whenever an observer target adjustment is desired. Matrix function E-1 (EOM) will automatically enter 9 in this function.
Failure to detect a change in charge during an adjust-fire mission	Data are fired with the wrong charge.	Whenever FADAC selects the charge, the operator should enter the selected charge in function B-1 (CHG) before computing subsequent observer corrections. This override will prevent the computer from automatically changing charges during the adjustment phase of a fire mission.
Failure to delete previously entered data when a new position is occupied	Erroneous firing data are computed.	Whenever a battery occupies a new position, the FADAC operator should follow the procedures outline in table 21 for matrix function E-2 (SET UP).

Table G-15. Common Mistakes and Malpractices—Continued

Description	Result	Preventive and corrective actions
Using the outdated data stored in memory	Solutions will be invalid.	The operator should verify all data entered into the computer memory. Whenever there is doubt as to what values the FADAC is using, the operator should use the recall functions as required. Most of the ballistic parameters (such as muzzle velocity, powder temperature, projectile weight, and met) will change from time to time. Records of current data should be maintained to facilitate a rapid check. As a minimum, if time permits, a check of all information should be made whenever the operator is changed. The new operator will then be aware of what data the computer is using in its computations.
Using incorrect procedures in the computation or entry of registration corrections	Firing data for all missions will be incorrect.	The operator should end the mission at the completion of the adjustment of fire during a registration. Before computing or entering registration corrections, the operator should enter all overrides in row B that were used during the registration, and correct the location of the registration point, high burst, or mean point of impact to compensate for base piece displacement. To make this correction, the operator must enter the grid and altitude of the registration point in functions A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT); the direction in which the battery is laid in function A-5 (OT DIR); the amount of the displacement in A-6 (RIGHT/LEFT) and A-7 (ADD/DROP) using the direction right/left and add/drop that will move the piece to the battery center; and then depress the COMPUTE button.
Entering registration corrections for the wrong charge	Firing data for all subsequent fire missions using the specific charges will be incorrect.	When the registration corrections are displayed, the KEYBOARD and IN-OUT indicators will remain lit. Prior to depressing the appropriate charge key, the operator should verify the registering charge with the fire direction officer.

G-10. Troubles and Preventive Measures

Most troubles are the direct result of poor preventive maintenance or failure of personnel to understand and follow correct preventive maintenance procedures. Such malpractices detract from the proficiency of a fire direction center and contribute to hardware failures. Many troubles and hardware failures can be prevented if the following simple maintenance rules are observed.

a. Generator maintenance.

(1) Emplace the generator on level ground.

(2) Keep it well ventilated and protected from the weather.

(3) Keep the fuel strainer clean and replace it when necessary.

(4) Maintain the correct oil level in the crankcase.

(5) Insure that the generator is producing 120/208-volt (±5 percent), 400-hertz (±5 percent) output and that no unauthorized equipment is operated from this power source.

(6) Ground the generator with the equipment provided.

(7) Alternate generator sets every 8 hours or more frequently if possible.

b. FADAC maintenance.

(1) Check the buttons, switches, keys, and cable connectors for dirt, rust, corrosion, looseness, bends, or breaks and have faulty items cleaned, repaired, or replaced.

(2) Turn off the FADAC before shutting off the generator.

(3) Clean the air filters daily.

(4) Cover the computer when it is not in use.

(5) Protect it from the weather, especially rain and direct sunlight.

(6) Each time the FADAC is put into operation, run program tests to check the memory.

(7) If the FADAC gets wet, dry it thoroughly before putting on the front and rear covers.

c. Corrective measures. Many of the common troubles that are experienced in the field can be *corrected by the operator.* The operator should use table G-16 as a guide to diagnose and attempt to correct troubles before notifying maintenance personnel.

Table G-16. FADAC Troubles and Operator Corrective Actions

Trouble indication	Step	Corrective action
1. No power	1	Insure that the FADAC circuit breaker is in the ON position.
	2	Insure that the generator circuit breaker is in the ON position. Adjust the generator for 120/208-volt output.
	3	Turn off the generator; then, check the power cable connections and tighten them if necessary.
	4	Insure that the 4-wire hookup on the generator cable and bracket adapter is correct. (See TM 5-6115-271-12.)

Table G-16. FADAC Troubles and Operator Corrective Actions—Continued

Trouble indication	Step	Corrective action	
2. No display for program test 1		Insure that a battery selector button has been depressed.	
3. Unintelligible output on display panel		Run program test 1	
4. Fails program test 1		Reprogram computer.	
5. Fails program test 2		Clear the indicated channel of memory by following the instructions in Table 22, Detailed Matrix 2 Functions.	
6. Automatically enters the wrong mode or fails to change modes as the result of a legal operator action	1	Depress the RESET button. If the failure recurs, turn off the FADAC, wait 10 seconds, then restart.	
	2	If the failure recurs, repeat the above action again, then run program test 1.	
	3	Repeated failure indicates a need for hardware repair or a requirement for reprograming.	
7. POWER READY light flashes	1	Insure that the marginal test switch is in the OFF position.	
	2	Remove rear cover unless cold weather operation requires that the rear cover remain on.	
	3	Send the computer to maintenance for repair of the blowers.	
8. TEMP light flashes		The computer's internal temperature is outside the limits for safe operation. One or more of the following actions is indicated:	
		Hot weather	Cold weather
	1	Remove the computer from the direct sunlight.	Install the rear cover.
	2	Check the air filters to insure they are not blocked or dirty.	Protect the computer from wind.
9. TRANSIENT light flashes	1	Depress the RESET button. If depressing the RESET button fails to stop the flashing light turn off the FADAC. Readjust the generator for 120/208-volt 400-hertz output.	
	2	Turn on the FADAC and run program test 1.	

Table G-16. FADAC Troubles and Corrective Actions-Continued

Trouble indication	Step	Corrective action
10. PARITY light flashes	1	Depress the RESET button. If this fails to stop the flashing light, turn off the FADAC. Wait 10 seconds, then restart.
	2	Run program test 2.
11. ERROR light flashes	1	Depress the RESET button.
	2	Check all inputs relating to the problem solution. Correct erroneous data.
	3	Run program test 1.
12. NO SOLUTION light flashes		See table 15.

Note. If the corrective actions fail to change the trouble indication, notify maintenance personnel.

G-11. Detailed Matrix Functions

The detailed use of each of the matrix 1 functions is presented in table G-17; use of the matrix 2 functions is detailed in table G-18. The information in these tables is presented as follows:

a. The "Matrix function" column identifies each function by the abbreviated designation that appears on the matrix overlay.

b. The "Matrix location" column indicates the location of each function on the input selection matrix by the letter button (A through H) and the number button (1 through 8) that are depressed to select the function. The functions are listed in tables G-17 and G-18 in alphabetical and numerical order from A-1 to H-8.

c. The "Battery associated" column in table G-17 indicates whether data entered by use of the indicated function are battery associated. If the word "Yes" appears in this column, a specific battery selector button must be depressed when the input data are entered to associate the data with that specific battery. If the word "No" appears in this column, it does not matter which battery selector button is depressed. In all cases, a battery selector button must be depressed to start the computations; otherwise, the NO SOLUTION indicator will flash. This column is not included in table G-18.

d. The "Entry procedure" column presents detailed instructions for entering data for a specific function or the steps in problem solution presented by a particular function. The instruction to "enter" certain data requires three separate actions: typing the data on the keyboard, checking the data displayed, and then depressing the ENTER key. Some functions require the entry of more than one element of information in a specific sequence. However, unless a specific entry sequence is indicated, information may be entered in any convenient sequence.

e. The "Recall procedure" column presents detailed instructions for recalling information stored in memory. Each matrix function that is not recallable is indicated by the abbreviation "NA" or an explanation of the recall procedure to be used.

f. The "Remarks" column contains comments about the function and cautions on its use.

Table G-17. Detailed Matrix 1 Functions

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
TGT EAST	A-1	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the target easting to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Target easting will be displayed.)	1. Used to enter easting coordinate of target. 2. A five-digit coordinate must be used. 3. Precision of entry may be to the nearest 0.01 meter. 4. Reset to minus zero by E-1 (EOM).
TGT NORTH	A-2	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the target northing to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Target northing will be displayed.)	1. Used to enter northing coordinate of target. 2. A five-digit coordinate must be used. 3. Precision of entry may be to the nearest 0.01 meter. 4. Reset to minus zero by E-1 (EOM).
TGT ALT	A-3	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the altitude to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Altitude will be displayed.)	1. Used to enter altitude of target above sea level. 2. Precision of entry may be to the nearest 0.01 meter. 3. Reset to minus zero by E-1 (EOM).
TGT RECALL	A-4	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the file number (1 to 128) of the target to be recalled. 3. Depress the ENTER key (Target coordinates and altitude will be displayed and automatically entered in A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT).	NA	The operator can recall the current battery-associated target by typing 0 in step 2 of the entry procedure.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
OT DIR	A-5	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the observer-target direction to the nearest mil (0 to 6,400 mils). 3. Depress the ENTER key.	Depress the RECALL key. (Observer-target direction will be displayed.)	1. Used to enter the azimuth from the observer to the target. 2. Reset to minus zero by E-1 (EOM). 3. This entry will not be used if B-4 (GT LINE ADJ) has been enabled.
RIGHT/ LEFT	A-6	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, depress the RIGHT or LEFT key and type the numerical value of the correction. (Depressing the RIGHT key will cause a plus sign (+) to be displayed; depressing the LEFT key will cause a minus sign (-) to be displayed.) 3. Depress the ENTER key.	Depress the RECALL key. (Correction will be displayed. A minus sign will be displayed for a LEFT correction; a plus sign will be displayed for a RIGHT correction.)	1. Target grid values will be modified as a result of the shift. 2. Automatically reset to plus zero during computation.
ADD/ DROP	A-7	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, depress the ADD or DROP key and type the numerical value of the correction. (Depressing the ADD key will cause a plus sign (+) to be displayed; depressing the DROP key will cause a minus sign (-) to be displayed.) 3. Depress the ENTER key.	Depress the RECALL key. (Correction will be displayed. A plus sign will be displayed for an ADD correction; a minus sign will be displayed for a DROP correction.)	1. Target grid values will be modified as a result of the shift. 2. Automatically reset to plus zero during computation.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery Associated	Entry procedure	Recall procedure	Remarks
UP/ DOWN	A-8	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, depress the UP or DOWN key and type the numerical value of the correction. (Depressing the UP key will cause a plus (+) sign to be displayed; depressing the DOWN key will cause a minus sign (-) to be displayed.) 3. Depress the ENTER key.	Depress the RECALL key. (Correction will be displayed. A plus sign will be displayed for an UP correction; a minus sign will be displayed for a DOWN correction.)	1. Target altitude will be modified as a result of the shift except for fuze time missions. 2. Automatically reset to plus zero during computation. 3. Whenever fuze time is used, an UP or DOWN correction will cause a change in fuze setting that, in turn, will change the altitude of the burst by the desired amount.
CHG	B-1	Yes	1. See remarks before using function. 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the appropriate charge flag. 4. Depress the ENTER key.	Depress the RECALL key. (Charge will be displayed.)	1. This is an override function. The computer will select its own charge unless this override is directed. 2. The operator may change the selected charge at any time during the mission by following the entry procedure. 3. This function must be used to enter a specific charge before function H-8 (COMP REG) is used. 4. When firing RAP with the motor on, enter flag 7 in step 3 of the entry procedure. 5. Reset to plus zero by E-1 (EOM).
HI ANGLE	B-2	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type 0 to cause the computer to solve the mission for high-angle fire.	Depress the RECALL key. (If high-angle fire has been selected for this mission, 0 will be	1. This override is selected to cause the computer to compute the mission for high-angle fire.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
HI ANGLE	B-2 (Cont)			displayed; if not, 9 will be displayed.)	If it is not selected, the computer will give the solution for low-angle fire. 2. After this function has been selected for a mission, firing data will be computed for high-angle fire until this function is dismissed. The following procedure is used to dismiss this function and return to low-angle fire: a. Perform step 1 of the entry procedure. b. Type 9 on the keyboard. (KEYBOARD indicator will go out.) 3. This function is dismissed automatically by E-1 (EOM).
ENABLE WHITE CHG	B-3	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type 0 to cause the computer to solve the mission by using white bag charges 3, 4, and 5 data for the 155-mm howitzer; charge 5 data for the 8-inch howitzer; or charges 1, 2, and 3 (M86 propellant) data for the 175-mm gun.	Depress the RECALL key. (If white bag charge has been selected for the mission, 0 will be displayed; if not, 9 will be displayed.)	1. This override is used to cause the computer to compute the mission for the overlapping white bag charges. 2. This function is dismissed by E-1 (EOM). 3. After this function has been selected and the SM key has been depressed, the operator can dismiss this function by typing 9 on the keyboard.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
GT LINE ADJ	B-4	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type 0 to cause the computer to use the gun-target azimuth in adjustment.	Depress the RECALL key. (If B-4 (GT LINE ADJ) has been selected for the mission, 0 will be displayed; if not 9 will be displayed.)	1. Used to effect corrections with respect to the gun-target line instead of the observer-target line. 2. This function overrides function A-5 (OT DIR). 3. This function is dismissed by E-1 (EOM). 4. The operator can recall the azimuth of the gun-target line by following the recall procedure outlined for A-5 (OT DIR). 5. After this function has been selected and the SM key has been depressed, the operator can dismiss this function by typing 9 on the keyboard.
PROJ TYPE	B-5	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the appropriate flag for the desired projectile type. (See tables 4 through 7.) 3. Depress the ENTER key.	Depress the RECALL KEY. (Shell model flag will be displayed.)	1. The computer normally selects shell HE. 2. This is an override function dismissed by E-1 (EOM) or by the selection of flag 1. 3. This override can be changed at any time during the mission.
FUZE TYPE	B-6	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the appropriate flag for the desired fuze type. (See tables 4 through 7.) 3. Depress the ENTER key.	Depress the RECALL key. (Fuze flag will be displayed.)	1. For fuze time or fuze VT and the appropriate projectile, the computer will compute a 20-meter height of burst (except for VT high-angle fire and nuclear rounds). 2. The computer will select fuze quick and display time of flight unless this

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
FUZE TYPE	B-6 (Cont)				override is directed. If fuze time or fuze VT is used, the fuze setting will be displayed instead of the time of flight. 3. This is an override function and is dismissed by E-1 (EOM) or by the selection of flag 1. 4. The program will subtract 2 seconds from the fuze setting for a zero height of burst (fuze time) to determine the fuze setting for base-ejection smoke rounds and CS gas projectile XM 629. 5. This override can be changed at any time during the mission. 6. See tables 4, 5, 6, and 7 for shell-fuze combinations.
NUC HOB	B-7	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the actual height of burst above the target. 3. Depress the ENTER key.	Depress the RECALL key. (Height of burst will be displayed.)	1. This function is used with the AE or HES projectile in the 155-mm or 8-inch howitzer programs. 2. The HOB value is <u>not</u> applied to the target altitude except in ballistic computations. 3. Reset to minus zero by E-1 (EOM).
MASS FIRE	B-8	Yes	1. Insure that the battery selector button for the battery with which the target is associated is depressed.	Depress the RECALL key. (Flags of batteries selected will be displayed.)	1. This function transfers the target associated with the battery selector button depressed in entry procedure 1 to the batteries

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
MASS FIRE	B-8 (Cont)		2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the flags of all batteries to be massed: Flag / Battery 1 A 2 B 3 C 4 D 5 E 4. Depress the ENTER key.		selected in entry procedure 3. 2. For each battery selected, the appropriate battery selector button must be depressed to cause the computer to compute the firing data for that battery. Specific overrides for each battery selected must be entered separately. 3. Reset to plus zero by E-1 (EOM).
OBS EAST	C-1	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the observer easting to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Observer easting will be displayed.)	1. Used to enter the observer easting for use in a high-burst or mean-point-of-impact registration or a polar plot mission. 2. A five-digit coordinate must be used; if not, the NO SOLUTION indicator will flash and the display will remain. 3. Precision of entry may be to nearest 0.01 meter.
OBS NORTH	C-2	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the observer northing to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Observer northing will be displayed.)	1. Used to enter the observer northing for use in a high-burst or mean-point-of-impact registration or a polar plot mission. 2. A five-digit coordinate must be used; if not, the NO SOLUTION indicator will flash and the display will remain. 3. Precision of entry may be to the nearest 0.01 meter.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
OBS ALT	C-3	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the observer altitude to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Altitude will be displayed.)	1. Used to enter the observer altitude for use in a high-burst or mean-point-of impact registration or a polar plot mission. 2. Precision of entry may be to nearest 0.01 meter.
OBS DIR	C-4	No	1. Depress the SM key. (KEYBOARD indicator will light.) If the observer location was recalled from the list the number of the observer for whom data are being entered or the last observer number previously recalled will appear in the right display window. 2. On the keyboard, type the observer direction to the nearest mil (0 to 6,400 mils). 3. Depress the ENTER key.	1. Depress the RECALL key. (Observer direction will be displayed.) 2. Depressing the RECALL key the second time will cause the first observer direction entered to appear. In each case, the number of the observer will also be displayed.	1. Used to enter the direction in a high-burst or mean-point-of-impact registration or to enter the observer direction in a polar plot mission. 2. Automatically set to minus zero during computation.
OBS HORIZ DIST	C-5	No	1. Depress the SM key. (KEYBOARD indicator will light.) If the observer location was recalled from the list, that observer number of the last observer number previously recalled will appear in the right display window. 2. On the keyboard, type the observer horizontal distance to the nearest meter. 3. Depress the ENTER key.	1. Depress the RECALL key. (Horizontal distance will be displayed.) 2. If two observer locations were recalled and the observer horizontal distance is entered for each, depressing the RECALL key the first time will cause the last observer horizontal distance entered to appear. Depressing the RECALL key the second time will cause the first observer horizontal distance entered to	1. Entry of data in this function prohibits entry of data in function C-6 (OBS SLANT DIST). 2. Automatically set to plus zero during computation. 3. Entry of data in function C-6 (OBS SLANT DIST) should not be attempted if data are entered in this function.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
OBS HORIZ DIST	C-5 (Cont)			appear. In each case, the number of the observer will also be displayed.	
OBS SLANT DIST	C-6	No	1. Depress the SM key. (KEYBOARD indicator will light. If the observer location was recalled from the list, that observer number or the last observer number previously recalled will appear in the right display window.) 2. On the keyboard, type the observer slant range to the nearest meter. 3. Depress the ENTER key.	1. Depress the RECALL key. (Slant distance will be displayed.) 2. If two observer locations were recalled and the observer slant distance is entered for each, depressing the RECALL key the first time will cause the last observer slant distance entered to appear. Depressing the RECALL key the second time will cause the first observer slant distance entered to appear. In each case, the number of the observer will also be displayed.	1. Entry of data in this function prohibits entry of data in function C-5 (OBS HORIZ DIST). 2. Automatically set to plus zero during computation. 3. Entry of data in function C-5 (OBS HORIZ DIST) should not be attempted if data are entered in this function.
OBS VERT ANGLE	C-7	No	1. Depress the SM key. (KEYBOARD indicator will light. If the observer location was recalled from the list, that observer number or the number of the last observer recalled will appear in the right display window.) 2. On the keyboard, type the appropriate sign (+ or -) and the observer vertical angle to the nearest mil (0 to $\pm$1, 600 mils). 3. Depress the ENTER key.	1. Depress the RECALL key. (Sign and angle will be displayed.) 2. The number of the observer will also be displayed. The number +8192 will appear for an observer for whom no vertical angle was entered.	1. A plus or minus sign (+ or -) must precede entry of the vertical angle. 2. Automatically set to +8192.00 during computation.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
POLAR PLOT TGT	C-8	Yes	1. Prior to using this function, recall the observer location by following the procedure outlined for D-4 (OBS RECALL) or enter the observer location by following the procedures outlined for C-1 (OBS EAST), C-2 (OBS NORTH), and C-3 (OBS ALT). Then enter the appropriate data by following the procedures outlined for functions C-4 (OBS DIR), C-5 (OBS HORIZ DIST) or C-6 (OBS SLANT DIST), and C-7 (OBS VERT ANGLE). 2. Depress the SM key. (COMPUTE indicator will light momentarily. Target grid and altitude will be displayed and automatically stored in matrix locations A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT). Observer direction is stored in A-5 (OT DIR).	NA	1. During computation, observer direction, distance, and vertical angle are automatically reset to minus zero, plus zero, and +8192. 00, respectively. 2. The vertical angle measured by the observer must be entered for the computer to display the correct target grid and altitude. If no angle is reported, enter +0. 3. If the observer reports the vertical displacement as a shift in meters, enter the amount of the vertical shift by using function A-8 (UP/DOWN). In this case a vertical angle of +0 is entered in location C-7 (OBS VERT ANGLE). If fuze time and shell HE are to be fired, the UP/DOWN function is not used. In this event the vertical shift is manually applied to the value in A-3 (TGT ALT).
LOCATE	D-1	No	1. Prior to using this function, recall the first observer grid and altitude by following the procedure outlined for D-4 (OBS RECALL). Then enter the direction to the unknown		1. Used to enable the intersection routine. 2. The following matrix functions are used with this function: A-1 (TGT EAST)

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
LOCATE	D-1 (Cont)		station by following the procedure outlined for C-4 (OBS DIR). If this observer measured the vertical angle, enter the vertical angle by following the procedure outlined for C-7 (OBS VERT ANGLE). The vertical angle must be entered for only one observer. 2. Repeat step 1 for the second observer. 3. Depress the SM key. (COMPUTE indicator will light momentarily and the grid and altitude of the unknown point will be displayed and automatically stored in functions A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT)).		A-2 (TGT NORTH) A-3 (TGT ALT) C-4 (OBS DIR) C-7 (OBS VERT ANGLE) D-4 (OBS RECALL)
ORIENT	D-2	No	1. Prior to using this function, enter the target grid and altitude by following the procedures outlined for matrix functions A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT) or the procedure outlined for A-4 (TGT RECALL). Recall the grid and altitude of the first observer by following the procedure outlined for D-4 (OBS RECALL) and then recall the grid and altitude of second observer in the same manner. 2. Depress the SM key. (The number of the second observer recalled will be displayed. KEYBOARD indicator will remain lit.)	NA	1. Used to enable the observer orientation routine for a high-burst and mean-point-of-impact registration. 2. The vertical angle displayed is for the target altitude entered in function A-3 (TGT ALT).

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
ORIENT	D-2 (Cont)		3. Depress the ENTER key. (The direction, distance, and vertical angle from the second observer to the target will be displayed in the appropriate windows.) 4. Depress the ENTER key again. (The number of the first observer will be displayed. KEYBOARD indicator will remain lit.) 5. Depress the ENTER key again. (The orienting data for the first observer will be displayed as described in step 3 above.)		
OBS STORE	D-3	No	1. Prior to using this function, enter the easting, northing, and altitude of the observer location by following the procedures outlined for C-1 (OBS EAST), C-2 (OBS NORTH), and C-3 (OBS ALT). 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the assigned number of the observer (1 to 18). 4. Depress the ENTER key.	See entry procedure for matrix location D-4 (OBS RECALL).	1. Until a new observer number is entered by the operator, the computer will associate the observer's location with the number entered in step 3 of the entry procedure. 2. The operator can clear all observer locations by typing 0.0 in step 3 of the entry procedures.
OBS RECALL	D-4	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the number of the observer location being recalled. 3. Depress the ENTER key. (The grid and altitude of the observer will be displayed and automatically	NA	

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
OBS RECALL	D-4 (Cont)		entered in matrix locations C-1 (OBS EAST), C-1 (OBS NORTH), and C-3 (OBS ALT).)		
TEMP MSN STORE	D-5	Yes	1. Insure that the appropriate battery selector button is depressed. 2. Depress the SM key. (KEYBOARD indicator will light.) 3. Type 0 on the keyboard.	NA	1. Target data corresponding to the battery selector button depressed will be stored temporarily. 2. Overrides and the observer-target direction for the mission will be stored temporarily. 3. After this function has been selected and the SM key has been depressed, the operator can dismiss the function by typing 9 on the keyboard.
TEMP MSN RECALL	D-6	Yes	1. Insure that the battery selector button for the battery for which the mission was stored is depressed. 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type 0. (The grid and altitude of the target will be displayed in the appropriate windows and the stored mission overrides will be entered automatically in the appropriate matrix locations.)	NA	After this function has been selected and the SM key has been depressed, the operator can dismiss the function by typing 9 on the keyboard.
REPLOT POLAR	D-7	Yes	Depress the SM key. (Azimuth, range, and angle of site from the selected battery to the target will be displayed.)	NA	1. Should be preceded by D-8 (REPLOT RECT) when registration corrections are being used. If not, the NO SOLUTION indicator will flash as a warning to indicate

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
REPLOT POLAR	D-7 (Cont)				that the displayed range will include any range correction being used.
REPLOT RECT	D-8	Yes	1. Depress the SM key. (The target grid used to establish the trajectory that hit the target will be displayed. The KEYBOARD indicator will remain lit.) 2. Compare the target altitude displayed with the altitude at the same location shown on a map of the area. If there is a difference in the altitudes, enter the map altitude. The new grid and altitude will be displayed and automatically stored in locations A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT). 3. Repeat step 2. If the altitudes agree within one-half contour interval, the target is properly located. 4. On the keyboard, depress the decimal point key to terminate the mode. 5. Store the replotted grid and altitude by using function E-3 (TGT STORE).	NA	1. Used to successively approximate the target location after adjusting the original altitude. 2. A ballistic trajectory computation will be used to determine the replot grid, and its accuracy will hinge on the accuracy of the convergence.
EOM	E-1	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type 0.	NA	1. Used to end a mission and to dismiss data associated with that mission. 2. Computer automatically dismisses: a. B-1 (CHG) override. b. B-2 (HI ANGLE). c. B-3 (ENABLE WHITE CHG).

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
EOM	E-1 (Cont)				d. B-4 (GT LINE ADJ). 3. Computer automatically sets: a. B-5 (PROJ TYPE) to HE, flag 1. b. B-6 (FUZE TYPE) to PD, flag 1. c. B-7 (NUC HOB) to minus zero. d. E-7 (MAX ORD) to plus zero. e. B-8 (MASS FIRE) to plus zero. f. A-1 (TGT EAST), A-2 (TGT NORTH), A-3 (TGT ALT), and A-5 (OT DIR) to minus zero. g. G-6 (DF INPUT), G-7 (TIME INPUT), and G-8 (QE INPUT) to minus zero. 4. After this function has been selected and the SM key has been depressed, the operator can dismiss the function by typing 9 on the keyboard or by depressing the RESET button.
SET UP	E-2	Yes	1. Depress the appropriate battery selector button. 2. Depress the SET UP button. (COMPUTE indicator will light.)	NA	1. Sets to standard the muzzle velocity, projectile weight, and powder temperature for the battery selected in step 1 of the entry procedure. 2. Sets values as described in the remarks for function E-1 (EOM).

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
SET UP	E-2 (Cont)				3. Sets to zero all registration corrections for the battery selected, including values entered in matrix 1 locations H-1 through H-5 and F-6 through F-8.
TGT STORE	E-3	Yes	1. Prior to using this function, enter target grid and altitude by following the procedures outlined for matrix function A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT). 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the assigned target file number (1 to 128). 4. Depress the ENTER key. (The COMPUTE indicator will light momentarily and the target grid and altitude will be displayed.)	See entry procedure for matrix location A-4 (TGT RECALL).	1. This function will be used to place a target on the target list in computer memory. 2. The NO SOLUTION indicator will flash if a number larger than 128 is entered. 3. Since 0 is reserved for recall of a battery-associated target, it cannot be used as a target number. 4. To store a target list from a tape, place the tape in the mechanical reader, close the armature (wide margin side of the tape toward the computer), and type the number 999 in step 3 of the entry procedures. 5. To clear all target locations, type 0. 0 in step 3 of the entry procedure.
INPUT MET MSG	E-4	No	1. The procedure for keyboard entry of a met message is as follows: a. Depress the SM key. (KEYBOARD indicator will light.) b. Type 0 on the keyboard. c. Depress the ENTER key. (The number 88 will be displayed.)	See entry procedure for matrix location E-5 (RECALL MET MSG).	1. This function is used to enter the meteorological message. Met data in the form of a computer met message are entered through the keyboard; data in paper tape form are entered through the mechanical tape reader.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
INPUT MET MSG	E-4 (Cont)		d. On the keyboard, type the 12-digit identification line of the met message, starting with the date-valid time group, as follows: 2 digits (day of month) 3 digits (time validity begins) 1 digit (number of hours the data will be valid) 3 digits (height of MDP above mean sea level in decameters) 3 digits (pressure in millibars) Note. The Nixie display will appear in the following formats: Abx xxxxx xxxxx xbbbb A = letter indicating which battery selector button was depressed b = unlit Nixie x = number e. Depress the ENTER key. The computer will then demand line 00 (00 will be displayed). f. On the keyboard, type the 16-digit 00 line as follows: 2 digits (00) 3 digits (wind direction to the nearest 10 mils) 3 digits (wind speed to the nearest knot) 4 digits (temperature in degrees Kelvin to the nearest 0. 1°) Note. Do not enter the decimal point.		2. Function H-6 (MET STD) overrides this function. Unless 9 has been entered in function H-6, the computer will display. . . . . 11 and the NO SOLUTION indicator will flash. This safeguard insures that the computer will automatically use current met data as soon as the data have been entered. 3. If a mistake is made before the line is entered, the operator can erase the line by depressing the CLEAR key. 4. The grid declination must be entered in function G-5 (GRID DECL) before function E-4 is used. 5. If the number of lines of the met message being entered is fewer than the number of lines of any met message previously entered, those lines of old data not overridden by the new met will be used by the computer for any trajectory whose maximum ordinate exceeds the height limit of met data entered. To remedy this situation, the operator should follow the procedure outlined for function E-6 (SINGLE MET LN INPUT) to enter the needed higher

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
INPUT MET MSG	E-4 (Cont)		4 digits (pressure to the nearest millibar) g. Depress the ENTER key. The computer will then demand line 01 (01 will be displayed). h. Enter each of the remaining lines in the same manner as that used for entering line 00. A maximum of 26 lines can be entered. When the last line has been entered, terminate the input mode by typing 9 on the keyboard. If the maximum number of lines is entered, the input mode will be automatically terminated. 2. The procedure for entering a met message tape is as follows: a. Load the tape into the tape reader. b. Insure that 9 has been entered in matrix location H-6 (MET STD). (See remark 2.) c. Depress the SM key. (KEYBOARD indicator will light.) d. Type 1 on the keyboard. e. Depress the ENTER key. (The reader will automatically feed the tape and end the mode.) If the computer does not accept a line of the met message through the tape reader, it will display the line number of the met message on which it has stopped and the KEYBOARD indicator will light. Manually enter the remainder of the met message as		lines of data. Temperature and pressure may be manually extrapolated from the last line of known data. Wind direction and speed should be duplicated from the last line of known data. 6. If a mistake is made in entry after the mode has been terminated, the procedure outlined for E-6 (SINGLE MET LN INPUT) may be used to enter needed correction.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
INPUT MET MSG	E-4 (Cont)		indicated in steps 1f through h, starting with the line for which the number is displayed.		
RECALL MET MSG	E-5	No	1. Depress the SM key. (KEYBOARD indicator will light and the identification line will be displayed.) 2. On the keyboard, type the number of the met message line to be recalled. (The line will be displayed.) 3. Repeat step 2 as required. 4. Depress the decimal point (.) key and then depress the ENTER key to terminate the mode.	NA	Function H-6 (MET STD) overrides this function. Unless 9 has been entered in function H-6, the computer will display . . . . 11 and the NO SOLUTION indicator will flash.
SINGLE MET LN INPUT	E-6	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the number of the met message line to be entered. 3. Depress the ENTER key. (KEYBOARD indicator will remain lit.) 4. On the keyboard, type the specific line data, beginning with the line number. 5. Depress the ENTER key. (KEYBOARD indicator will go out.)		1. This function is used only to enter an individual line of met. 2. The input mode terminates when step 5 is performed. Function E-4 (INPUT MET MSG) must be used to enter the ID line.
MAX ORD	E-7	Yes	NA	Depress the RECALL key. (The maximum ordinate for the last computed trajectory will be displayed.)	1. Used to determine the maximum ordinate of the trajectory of a projectile fired with the displayed firing data.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
MAX ORD	E-7 (Cont)				2. Ordinate will be displayed in feet above sea level. 3. Set to plus zero by function E-1 (EOM).
DERIVE MV	E-8	Yes	1. Prior to using this function: a. Enter or recall the registration point grid and altitude by following the procedures outlined for functions A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT) or function A-4 (TGT RECALL). b. Enter the appropriate flags that were used during registration by following the procedures outline for the functions B-1 (CHG), B-2 (HI ANGLE), and B-3 (ENABLE WHITE CHG). c. Enter the adjusted quadrant elevation by following the procedure outlined for function G-8 (QE INPUT). 4. Depress the SM key. (COMPUTE indicator will light. The charge, derived muzzle velocity, and projectile flag will be displayed.)	NA	1. Used to determine the muzzle velocity required to produce the adjusted quadrant elevation entered in function G-8 (QE INPUT). The output data of this function should be used only when muzzle velocity was the only unknown ballistic parameter during registration. 2. The derived muzzle velocity may be compared to a manually determined algebraic sum of velocity error and standard velocity. Like VE, it incorporates the errors of met and survey.
NO FIRE AREA EAST	F-1	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the area easting to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Easting will be displayed.)	1. Used to enter the no-fire area easting coordinate. 2. A five-digit coordinate must be used. 3. An entry of 00000 is used to clear a specific no-fire area; however, an actual easting of 00000 must be entered as 00001.

Table G-17. Detailed Matrix 1 Function—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
NO FIRE AREA NORTH	F-2	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the area northing to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Northing will be displayed.)	1. Used to enter the northing coordinate of the no-fire area. 2. Five-digit coordinate must be used.
NO FIRE AREA RADIUS	F-3	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the area safe radius to the nearest meter.	Depress the RECALL key. (Safe radius will be displayed.)	1. Used to enter the no-fire area safe radius. 2. A radius greater than 49999 meters should not be entered. 3. If more than one safe radius is applicable to the same area, see remark 4 for matrix location F-4 (NO FIRE AREA STORE).
NO FIRE AREA STORE	F-4	No	1. Prior to using this function, enter no-fire area data by following the procedures outlined for matrix functions F-1 (NO FIRE AREA EAST), F-2 (NO FIRE AREA NORTH), and F-3 (NO FIRE AREA RADIUS). 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the file number (1 to 42) assigned to the no-fire area. 4. Depress the ENTER key. (COMPUTE indicator will light momentarily, and the grid and safe radius of the area will be displayed.)	NA	1. Used to store the easting, northing, and safe radius entered in F-1, F-2, and F-3. Up to 42 no-fire areas can be stored. 2. To delete a specific no-fire area from the list, enter 00000 in F-1, F-2, and F-3 and then follow steps 2, 3, and 4 of the entry procedures for function F-4. 3. To clear all no-fire areas, type 0.0 in step 3 of the entry procedures and then depress the ENTER key. 4. When two or more areas that have identical centers are to be checked for two different types of shells with different safe radii, the area with the smallest radius

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
NO FIRE AREA STORE	F-4 (Cont)				must be stored with a lower number.
NO FIRE AREA RECALL	F-5	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the file number of the area to be recalled. 3. Depress the ENTER key. (The no-fire area grid and radius will be displayed and automatically entered in F-1 (NO FIRE AREA EAST), F-2 (NO FIRE AREA NORTH), and F-3 (NO FIRE AREA RADIUS).)	Depress the RECALL key. (The number of the no-fire area causing the NO SOLUTION indicator to flash will be displayed. (See remark.)	The recall procedure for this function is used to determine the number of the no-fire area causing the NO SOLUTION indicator to flash coincident with the display of firing data.
DF CORR	F-6	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the flag for the applicable charge. 3. Depress the ENTER key. (KEYBOARD indicator will remain on.) 4. On the keyboard, depress the RIGHT or LEFT key and type the numerical value of the deflection correction. 5. Depress the ENTER key.	1. Depress the RECALL key. (KEYBOARD indicator will light.) 2. On the keyboard, type the flag for the applicable charge. 3. Depress the ENTER key. (Deflection correction will be displayed.)	1. Used to enter a deflection correction for a specific charge for a designated battery. 2. The deflection correction entered in this function will not be applied unless a range K value has been entered in matrix location F-8 (RANGE/K) or has previously been entered automatically with matrix location H-8 (COMP REG). 3. The deflection correction will be associated with the projectile type currently entered in matrix location B-5 (PROJ-TYPE).

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
TIME CORR	F-7	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the flag for the applicable charge. 3. Depress the ENTER key. (KEYBOARD indicator will remain lit.) 4. On the keyboard, type the appropriate sign (+ or -) and the numerical value of the correction. 5. Depress the ENTER key.	1. Depress the RECALL key. (KEYBOARD indicator will light.) 2. On the keyboard, type the flag for the applicable charge. 3. Depress the ENTER key. (Time correction will be displayed.)	1. Used to enter a time correction for a specific charge for a designated battery. 2. The time correction entered in this function <u>will not</u> be applied unless a range K value has previously been entered or is being entered in conjunction with the time correction. 3. The time correction will be associated with the fuze type currently entered in matrix location B-6 (FUZE TYPE).
RANGE/ K	F-8	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the flag for the applicable charge. 3. Depress the ENTER key. (KEYBOARD indicator will remain lit.) 4. On the keyboard, type the appropriate sign (+ or -) and the numerical value of range K. 5. Depress the ENTER key.	1. Depress the RECALL key. (KEYBOARD indicator will light.) 2. On the keyboard, type the flag for the applicable charge. 3. Depress the ENTER key. (The value of range K will be displayed.)	1. Used to enter range K for a specific charge for a designated battery. 2. A range K value <u>must be</u> entered if corrections for deflection and/or time have been entered in F-6 (DF CORR) and/or F-7 (TIME CORR).
MV	G-1	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type a two- or three-digit flag. The first two digits will be the projectile flag and the last digit will be the charge flag. 3. Depress the ENTER key. (KEYBOARD indicator will remain lit.)	1. Depress the RECALL key. (KEYBOARD indicator will light.) 2. On the keyboard, type the projectile-charge flag as outlined in step 2 of the entry procedure. 3. Depress the ENTER key. (Muzzle velocity will be displayed.)	1. Used to enter the nonstandard muzzle velocity derived from a registration or extrapolated from chronograph measurement. 2. Example of flag entry: <u>Description</u> <u>Flag</u> Shell HE, chg 6 16 3. See tables 8 through 14 for standard MV.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
MV	G-1 (Cont)		4. On the keyboard, type the muzzle velocity to the nearest 0.1 meter per second. 5. Depress the ENTER key.		4. If a nonstandard MV is entered for any shell in the HE group, the nonstandard MV is automatically applied to all others in the group. Also, 8-inch HES corrections are applied to the nuclear projectile. 5. Enter a 0 in B-3 (ENABLE WHITE CHG) before entering nonstandard muzzle velocities for white bag charge 3, 4, or 5.
POWD TEMP	G-2	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the sign (+ or -) and numerical value of the powder temperature to the nearest degree Fahrenheit. 3. Depress the ENTER key.	Depress the RECALL key. (Powder temperature will be displayed.)	1. Used to enter powder temperature for use in the cannon program. 2. The entry of powder temperature for use in the cannon program does not interfere with the data entered for use in the chronograph extrapolation program and vice versa.
PROJ WT	G-3	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the flag for the applicable projectile type. 3. Depress the ENTER key. (KEYBOARD indicator will remain lit.) 4. On the keyboard, type the projectile weight to the nearest 0.1 pound. 5. Depress the ENTER key.	1. Depress the RECALL key. (KEYBOARD indicator will light.) 2. To recall PROJ WT, type on the keyboard the flag for the projectile weight to be recalled. 3. Depress the ENTER key. (The stored weight of the projectile will be displayed.)	1. Used to enter projectile weight for use in the cannon program. 2. See tables 4 through 7 for standard projectile weights. 3. The entry for projectile weight for use in the cannon program does not interfere with the data entered for use in the chronograph extrapolation program and vice versa.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
LAT	G-4	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the appropriate sign (+ or -) and the numerical value of the battery latitude to the nearest degree. (See remark 1.) 3. Depress the ENTER key.	Depress the RECALL key. (Latitude will be displayed.)	1. Enter a plus sign (+) if the battery is located in the Northern Hemisphere; enter a minus sign (-) if the battery is located in the Southern Hemisphere. 2. The latitude entered for one battery will be applied to all batteries. Range of input is from 0 to ±84°. 3. This latitude entry is used in the ballistic routine.
GRID DECL	G-5	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the appropriate sign (+ or -) and the numerical value of the grid declination angle to the nearest mil. (See remark 1.) 3. Depress the ENTER key.	Depress the RECALL key. (Grid declination angle will be displayed.)	1. Used to convert the wind azimuth from true north to grid north. If grid north is to the right of true north, enter a plus sign (+); if grid north is to the left of true north, enter a minus sign (-). 2. This function must be used before E-4 (INPUT MET MSG) is used. Range of input is from 0 to ±70 mils.
DF INPUT	G-6	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the correct deflection to the nearest mil. 3. Depress the ENTER key.	Depress the RECALL key. (Input deflection will be displayed.)	1. Used to enter the correct deflection after a registration. The correct deflection is used by the computer to determine the deflection correction. 2. Set to minus zero by E-1 (EOM).
TIME INPUT	G-7	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the adjusted time to the nearest 0.1 second.	Depress the RECALL key. (Adjusted time will be displayed.)	1. Used to enter the adjusted time after a registration. The adjusted time will be used by the computer

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
TIME INPUT	G-7 (Cont)	Yes	3. Depress the ENTER key.		to determine the fuze correction. 2. Value will be set to minus zero by E-1 (EOM).
QE INPUT	G-8	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the adjusted quadrant elevation to the nearest mil. 3. Depress the ENTER key.	Depress the RECALL key. (Adjusted quadrant elevation will be displayed.)	1. Used to enter the adjusted quadrant elevation after a registration. 2. Set to minus zero by E-1 (EOM).
BTRY EAST	H-1	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the battery easting to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Battery easting will be displayed.)	1. A five-digit coordinate must be used; if not, the NO SOLUTION indicator will flash and the display will remain. 2. Set to plus zero by E-2 (SET UP).
BTRY NORTH	H-2	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the battery northing to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Battery northing will be displayed.)	1. A five-digit coordinate must be used; if not, the NO SOLUTION indicator will flash and the display will remain. 2. Set to plus zero by E-2 (SET UP).
BTRY ALT	H-3	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the battery altitude to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Battery altitude will be displayed.)	1. Used to enter the altitude of the battery above sea level. 2. Negative inputs will not be accepted. 3. If the battery altitude is below sea level, use relative altitudes for the observers, targets, and battery by adding the same positive value to the altitude of each before entering the altitude data into the computer.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
BTRY ALT	H-3 (Cont)				4. Set to plus zero by E-2 (SET UP).
BTRY AZ LAID	H-4	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the battery azimuth to the nearest mil. 3. Depress the ENTER key.	Depress the RECALL key. (Battery azimuth will be displayed.)	Set to plus zero by E-2 (SET UP).
BTRY DF	H-5	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the referred deflection to the nearest mil. 3. Depress the ENTER key.	Depress the RECALL key. (Battery referred deflection will be displayed.)	Set to plus zero by E-2 (SET UP).
MET STD	H-6	No	1. Depress the SM key. (KEYBOARD indicator will light.) 2. Type 0 on the keyboard. (KEYBOARD indicator will go out; COMPUTE indicator will flash.)	Depress the RECALL key. (If standard met is being used, a 0 will be displayed; if current met is being used, a 9 will be displayed.)	1. An entry of 0 in step 2 of the entry procedure will cause the computer to use standard met. 2. To allow the computer to accept and use current met, type 9 instead of 0 in step 2 of the entry procedure.
ZERO CORR	H-7	Yes	1. Depress the SM key. (KEYBOARD indicator will light.) 2. Type 0 on the keyboard. (KEYBOARD indicator will go out; COMPUTE indicator will flash.)	NA	1. This function deletes all registration corrections for the battery designated. 2. Typing 9 instead of 0 in step 2 of the entry procedure will dismiss this function without setting the registration corrections to zero. 3. The setup procedure outlined under matrix function E-2 (SET UP) will also set all registration corrections to zero for the battery selected.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
ZERO CORR	H-7 (Cont)				4. Selection of function H-8 (COMP REG) will also automatically set previous registration corrections to zero for the specific charge and battery selected. Corrections for other charges will not be set to zero.
COMP REG	H-8	Yes	1. The procedures for computing the corrections for precision and time registrations are as follows: a. The computer is used to compute firing data during the conduct of the registration. The steps are as follows: (1) Select the battery to which the corrections will apply and depress the appropriate battery selector button. (2) Recall or enter the coordinates and altitude of the registration point by following the procedure outlined for A-4 (TGT RECALL) or the procedures outlined for A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT). (3) Select a specific charge for the registration by following the procedure outlined for B-1 (CHG). (4) Compute the firing data during the conduct of the registration. b. To compute the registration corrections and apply them to	NA	1. This function is used to determine the registration corrections after a precision, high-burst, or mean-point-of-impact registration. 2. Selection of this function automatically sets to zero previous registration corrections for specific charge and battery selected. 3. If the base piece is displaced from the battery center, the grid of the registration point must be corrected by the amount of the displacement and the corrected grid entered in steps 1a(2) and 1b(1) of the entry procedures. 4. The registration corrections displayed by the computer are the residual corrections between the data required to hit the registration point (adjusted data) and the "should hit" data the computer has determined by using the parameters for weather and material previously entered into the computer.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
COMP REG	H-8 (Cont)		subsequent computations-- (1) Reenter or recall the grid and the altitude of the registration point as outlined in step a(2). See remark 3. (2) Enter the correct deflection, adjusted time (time registration only), and adjusted quadrant elevation by following the procedures outlined for G-6 (DF INPUT), G-7 (TIME INPUT), and G-8 (QE INPUT). (3) Enter the appropriate fuze flag by following the procedure outlined for B-6 (FUZE TYPE) if a time registration was fired. (4) Enter 0 in B-2 (HI ANGLE) if a high-angle registration was fired. (5) Enter the appropriate charge flag by following the procedure outlined for B-1 (CHG). (6) Depress matrix buttons H-8 (COMP REG). (Matrix window will light.) (7) Depress the COMPUTE button. (Disregard the displayed data.) (8) Depress the SM key. (Corrections will be computed and displayed.) (9) To store the registration corrections for the charge used, type the appropriate charge flag on the keyboard and depress the ENTER key. (KEYBOARD indicator will remain lit.)		The displayed corrections are not the same as those used in manual computations, which exclude some factors (such as drift) that are automatically included by the computer. Corrections will be displayed as follows: a. The deflection correction will be displayed to the nearest mil in the DEFLECTION window. The direction (sign) of the correction will appear in the SIGN window. A plus sign (+) indicates a RIGHT correction; a minus sign (-) indicates a LEFT correction. b. The fuze correction will be displayed to the nearest 0.1 second in the FUZE SETTING window. The sign of the correction will be displayed on the first Nixie tube in the window. A blank tube will indicate a plus correction; 9 will indicate a minus correction. c. The range correction will be displayed as range K (meters/1000) in the QUADRANT window. The sign of the correction will be displayed in the same manner as the sign of the fuze correction.

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
COMP REG	H-8 (Cont)		(10) To store the corrections for the nonregistering batteries, depress the appropriate battery selector button and repeat the procedure outlined in step (9) above for each battery desired. (11) After the corrections have been stored for the batteries desired, depress the decimal point key and then depress the ENTER key to terminate the mode. (KEYBOARD indicator will go out.) 2. The procedures for conducting a high-burst or mean-point-of-impact registration are as follows: a. Using the entry procedure for function D-2 (ORIENT), orient the observers on the target base and compute the grid and altitude of the high-burst or mean-point-of-impact location as follows: (1) Depress the battery selector button for the battery to which the corrections will apply. (2) Enter the grid and altitude of the selected high-burst or mean-point-of-impact by following the procedures outlined for A-1 (TGT EAST), A-2 (TGT NORTH), and A-3 (TGT ALT). (The actual altitude of a high burst must be entered in A-3. When 8-inch HES shell is fired, enter 0 in B-7 (NUC HOB).)		5. Current meteorological data, projectile weight, powder temperature, and muzzle velocity for the charge concerned should be entered into the computer before the registration corrections are computed. The corrections displayed by the computer will be functions of any parameters left at standard, inaccuracies of measurement, the age of the met data, and the other materiel parameter entered. Registration corrections will be associated with the battery, charge, projectile family, and trajectory. 6. The computer may be used to assist in determining the following data for a precision registration: a. Angle T. After entry of the registration point, grid, and altitude, follow the procedure outlined for D-7 (REPLOT POLAR) to determine the azimuth and range from the battery to the registration point. Manually compare the battery-registration point azimuth to determine the angle T.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
COMP REG	H-8 (Cont)		(3) Compute the orienting data by following the procedure outlined for function D-2 (ORIENT). Orient observers as outlined in FM 6-40. (4) Using the entry procedures for A-3 (TGT ALT), enter the actual altitude of the high burst minus 20 meters to compensate for the 20 meters automatically added by the computer for fuze time missions. (5) Enter the appropriate mission overrides by following the procedures outlined for the pertinent functions in row B. (6) Depress the COMPUTE button. The firing data will be displayed. b. To compute registration corrections and to cause the computer to apply them to subsequent computations-- (1) Manually determine the average azimuths and the vertical angle from the observer base. (2) Compute the location of the high burst or mean-point-of-impact by performing the entry procedure outlined for D-1 (LOCATE). (3) Enter the correct deflection, adjusted time, and quadrant elevation by following the procedures outlined by G-6 (DF INPUT), G-7 (TIME INPUT), and G-8 (QE INPUT).		b. Site. Enter the registration point grid and altitude into the computer. (1) Compute the firing data in the normal manner. (2) Change the target altitude to equal the battery altitude. (3) Compute the firing data. (4) Subtract the quadrant elevation determined in step (3) above from the quadrant elevation determined in step (1) above. The difference will be the site. (5) Reenter the correct target altitude for subsequent corrections.

Table G-17. Detailed Matrix 1 Functions—Continued

Matrix function	Matrix location	Battery associated	Entry procedure	Recall procedure	Remarks
COMP REG	H-8 (Cont)		(4) Follow the procedures outlined in 1b(3) through 1b(11). See remark 3.		

Table G-18. Detailed Matrix 2 Functions

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
CHRON PRESS	A-1	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the atmospheric pressure. 3. Depress the ENTER key.	Depress the RECALL key. (Atmospheric pressure will be displayed.)	1. Used to enter the surface air pressure for use in the chronograph muzzle velocity extrapolation routine. 2. The air pressure value is obtained from the 00 line of the computer met message.
CHRON DELAY	A-2	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the delay gate setting. 3. Depress the ENTER key.	Depress the RECALL key. (Delay gate setting will be displayed.)	1. Used to enter the delay gate setting for use in the chronograph muzzle velocity extrapolation routine. 2. This setting value is obtained from the chronograph operator. 3. Range of input is from 1 to 10.
CHRON CHG	A-3	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the appropriate charge flag. 3. Depress the ENTER key.	Depress the RECALL key. (Charge flag will be displayed.)	1. Used to enter the charge fired for use in the chronograph muzzle velocity extrapolation routine. 2. If white bag propellant for the 155-mm or 8-inch howitzers or M86 propellant for the 175-mm gun was used, 0 must be entered in B-3 (ENABLE WHIT CHG).
CHRON PROJ TYPE	A-4	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the appropriate projectile flag. 3. Depress the ENTER key.	Depress the RECALL key. (Projectile flag will be displayed.)	Used to enter the appropriate projectile flag for use in the chronograph muzzle velocity extrapolation routine.
CHRON PWD TEMP	A-5	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the appropriate sign (+ or -) and the numerical value of the powder temperature to the nearest degree Fahrenheit. 3. Depress the ENTER key.	Depress the RECALL key. (Powder temperature will be displayed.)	1. Used to enter the powder temperature for use in the chronograph muzzle velocity extrapolation routine. 2. A plus or minus sign (+ or -) must precede entry of the temperature value.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
CHRON PROJ WT	A-6	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the projectile weight. 3. Depress the ENTER key.	Depress the RECALL key. (Projectile weight will be displayed.)	1. Used to enter the projectile weight for use in the chronograph muzzle velocity extrapolation routine. 2. Projectile weight is entered to the nearest 0.1 pound.
CHRON QE FIRED	A-7	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the quadrant elevation fired. 3. Depress the ENTER key.	Depress the RECALL key. (Quadrant elevation will be displayed.)	1. Used to enter the quadrant elevation fired for use in a chronograph muzzle velocity extrapolation routine. 2. Quadrant elevation may be entered to an accuracy of 0.01 mil.
CHRON MEAS VEL	A-8	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the M36 chronograph-measured velocity to the nearest 0.1 meter per second. 3. Depress the ENTER key. 4. Depress the SEND button. (COMPUTE indicator will light during computation.) 5. Repeat steps 2, 3, and 4 for subsequent rounds. (See remark 3.)	Depress the RECALL key. (Measured velocity will be displayed.)	1. Used to enter the M36 chronograph measured velocity. 2. Muzzle velocity is computed with data entered in A-1 through A-8 and B-3. 3. Data for subsequent rounds need not be reentered in A-1 through A-7 unless a specific value has changed. Ordinarily, the measured muzzle velocity is the only value that will change during the firing of a group of rounds for the determination of muzzle velocity. However, all data entered in A-1 through A-7 should be checked, since previously entered data remain stored until they are overriden.
	B-1	Not used.		
	B-2	Not used.		
ENABLE WHITE CHG	B-3	1. Depress the SM key. (KEYBOARD indicator will light.) 2. Type 0 on the keyboard. (See remark 1.)	Depress the RECALL key. (If white bag charge has been selected for the mission, 0 will be displayed.)	1. An entry of 0 in step 2 of the entry procedure will cause the computer to use data for white bag charges for the 155-mm and 8-inch howitzers and for propellant M86 for the 175-mm gun.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
ENABLE WHITE CHG	B-3 (Cont)			2. To dismiss this function, the operator must type 9 in step 2 of the entry procedure.
	B-4	Not used.		
	B-5	Not used.		
	B-6	Not used.		
	B-7	Not used.		
	B-8	Not used.		
OBS EAST	C-1	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the observer easting to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Observer easting will be displayed.)	1. Used to enter the observer easting for use in traverse survey or the polar plot of a known point. 2. A five-digit coordinate must be used; if not, the NO SOLUTION indicator will flash and the display will remain. 3. Precision of entry may be to the nearest 0.01 meter. 4. Reset to computed value during traverse computation.
OBS NORTH	C-2	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the observer northing to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Observer northing will be displayed.)	1. Used to enter the observer northing for use in traverse survey or the polar plot of a known point. 2. A five-digit coordinate must be used; if not, the NO SOLUTION indicator will flash and the display will remain. 3. Precision of entry may be to the nearest 0.01 meter. 4. Reset to computed value during traverse computation.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
OBS ALT	C-3	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the observer altitude to the nearest meter. 3. Depress the ENTER key.	Depress the RECALL key. (Altitude will be displayed.)	1. Used to enter the observer altitude for use in traverse survey or the polar plot of a known point. 2. Precision of entry may be to the nearest 0.01 meter. 3. Reset to the computed value during traverse computation.
OBS DIR	C-4	1. Depress the SM key. (KEYBOARD indicator will light. If the observer location was recalled from the list, that observer number or the last observer number previously recalled will appear in the right display window.) 2. On the keyboard, type the observer direction to the nearest mil (0 to 6,400 mils). 3. Depress the ENTER key.	1. Depress the RECALL key. (Observer direction will be displayed.) 2. If two observer locations were recalled and the observer direction is entered for each, depressing the RECALL key the first time will cause the last observer direction entered to appear. Depressing the RECALL key the second time will cause the first observer direction entered to appear. In each case, the number of the observer will also be displayed.	1. Used to enter the azimuth for use in traverse survey or to enter the observer direction in the polar plot of a known point. 2. Automatically set to minus zero during computation.
OBS HORIZ DIST	C-5	1. Depress the SM key. (KEYBOARD indicator will light. If the observer location was recalled from the list, that observer number or the last observer number previously recalled will appear in the right display window.)	1. Depress the RECALL key. (Observer horizontal distance will be displayed.) 2. If two observers were recalled and the observer horizontal distance is entered for	1. Entry of data in this function prohibits entry of data in C-6 (OBS SLANT DIST). 2. Automatically set to plus zero during computation. 3. Entry of data in C-6 (OBS SLANT DIST) should not be attempted if data have been entered in this function.

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
OBS HORIZ DIST	C-5 (Cont)	2. On the keyboard, type the observer horizontal distance to the nearest meter. 3. Depress the ENTER key.	each, depressing the RECALL key the first time will cause the last observer horizontal distance entered to appear. Depressing the RECALL key the second time will cause the first observer horizontal distance entered to appear. In each case, the number of the observer will also be displayed.	
OBS SLANT DIST	C-6	1. Depress the SM key. (KEYBOARD indicator will light.) If the observer location was recalled from the list, that observer number or the last observer number previously recalled will appear in the right display window.) 2. On the keyboard, type the observer slant range to the nearest meter. 3. Depress the ENTER key.	1. Depress the RECALL key. (Observer slant distance will be displayed.) 2. If two observer locations were recalled and the observer slant distance is entered for each, depressing the RECALL key the first time will cause the last observer slant distance entered to appear. Depressing the RECALL key the second time will cause the first observer slant distance entered to appear. In each case, the number of the observer will also be displayed.	1. Entry of data in this function prohibits entry of data in C-5 (OBS HORIZ DIST). 2. Automatically set to plus zero during computation. 3. Entry of data in C-5 (OBS HORIZ DIST) should not be attempted if data have been entered in this function.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
OBS VERT ANGLE	C-7	1. Depress the SM key. (KEYBOARD indicator will light. If the observer location was recalled from the list, that observer number or the last observer number previoulsy recalled will appear in the right display window.) 2. On the keyboard, type the observer vertical angle value to the nearest mil (0 to ± 1, 600 mils). 3. Depress the ENTER key.	1. Depress the RECALL key. (Sign and angle will be displayed.) 2. The number of the observer will also be displayed. The number +8192 will appear for an observer for whom no vertical angle was entered.	1. A sign (+ or -) must precede entry of the vertical angle value. 2. Automatically set to +8192. 00 during computation.
POLAR PLOT KNPT	C-8	1. Prior to using this function, enter the grid and altitude of the radar set or the laser equipped observer by following the procedures outlined for matrix functions C-1 (OBS EAST), C-2 (OBS NORTH), and C-3 (OBS ALT) and store this location by following the procedure outlined for matrix function D-3 (OBS STORE). Then enter the appropriate data for polar plot computations by following the procedures outlined for C-4 (OBS DIR), C-6 (OBS SLANT DIST), and C-7 (OBS VERT ANGLE). Only slant distance should be entered, since the radar set and laser range finder measures slant distance. A vertical angle value must be entered. If no vertical angle is reported, enter +0. 2. Depress matrix buttons C-8 (POLAR PLOT KNPT). (Matrix window will light.)	NA	1. This function is used only to initiate the computation of the grid location by polar plot for subsequent use in a trilateration computation. Entries are required in C-1 through C-4, C-5 or C-6, and C-7. 2. The number of the known point entered in step 4 will determine whether data are stored in locations G-1, G-2, and G-3 or H-1, H-2, and H-3. 3. To insure the correct computation of an unknown observer's location in the trilateration scheme, known point 1 is always left of known point 2.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
POLAR PLOT KNPT	C-8 (Cont)	3. Depress the SM key. (KEYBOARD indicator will light.) 4. On the keyboard, type the number of the known point (1 or 2, depending on which known point data are to be computed.) 5. Depress the ENTER key. (COMPUTE indicator will light during computation. The coordinates and altitude of the known point will be displayed and automatically stored. (See remark 2.) 6. Repeat the procedure outlined in steps 1 through 5 for the second known point, beginning with the entry of the observer direction in C-4 (OBS DIR).		
	D-1	Not used.		
	D-2	Not used.		
OBS STORE	D-3	1. Prior to using this function, enter the observer easting, northing, and altitude by following the procedures outlined for C-1 (OBS EAST), C-2 (OBS NORTH), and C-3 (OBS ALT). 2. Depress the SM key. (KEYBOARD indicator will light.) 3. On the keyboard, type the assigned number of the observer (1 to 18). 4. Depress the ENTER key.	See entry procedure for D-4 (OBS RECALL).	1. Until a new observer number is entered by the operator, the computer will associate the observer location with the number entered in step 3 of the entry procedure. 2. To clear all observer locations, type 0.0 in step 3 of the entry procedures.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
OBS RECALL	D-4	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the number of the observer being recalled. 3. Depress the ENTER key. (The coordinates and altitude of the observer will be displayed and automatically entered in C-1 (OBS EAST), C-2 (OBS NORTH), and C-3 (OBS ALT).	NA	
	D-5	Not used.		
	D-6	Not used.		
	D-7	Not used.		
COMP TRAV	D-8	1. Prior to using this function, enter the appropriate data for the first leg of the traverse by following the entry procedures outlined for C-1 through C-4, C-5 or C-6, and C-7. The azimuth of the first leg is computed manually and entered as the observer direction in matrix function C-4 (OBS DIR). Only one distance, either horizontal distance or slant distance, may be entered. If no vertical angle is reported, enter ± 0. 2. Depress matrix buttons D-8 (COMP TRAV). (Matrix window will light.) 3. Depress the SM key. (COMPUTE indicator will light during computation, and the grid and altitude of the forward station will	NA	1. This function is used only to initiate the computation of a grid from azimuth and distance of each station along a traverse. 2. Entries are required in C-1 through C-4, C-5 or C-6, and C-7. 3. When the grid and altitude of each station are computed, the operator may store them by following the procedure outlined for D-3 (OBS STORE). As many as 18 stations may be stored on the observer list. 4. It is important to remember that locations stored on the list can also be used with matrix 1, as there is only one observer list in memory. Care must be exercised not to inadvertently erase a stored value by storing different data in a location already used. To avoid this, use the recall procedure to determine what data are stored in memory

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
COMP TRAV	D-8 (Cont)	be displayed and automatically stored in C-1 (OBS EAST), C-2 (OBS NORTH), and C-3 (OBS ALT)). 4. Continue to compute the traverse by repeating the procedure outlined in steps 1 through 3, beginning with the entry of the azimuth to the forward station in C-4 (OBS DIR).		before beginning a traverse computation.
STA EAST	E-1	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the 100,000-meter designator (one digit) and the easting coordinate (five digits) of the station (target) to be transformed (five digits). 3. Depress the ENTER key.	Depress the RECALL key. (Station easting will be displayed.)	1. Used to enter the easting coordinate of a station for use in zone-to-zone transformation. 2. Entry to the nearest 0.01 meter may be made. 3. A six-digit entry must be made to correctly define the station easting coordinate. 4. The entered value will be set to minus zero during computation with E-8 (COMP ZONE TO ZONE).
STA NORTH	E-2	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the 100,000-meter designator (two digits) and the northing coordinate (five digits) of the station (target) to be transformed. 3. Depress the ENTER key.	Depress the RECALL key. (Station northing will be displayed.)	1. Used to enter the northing coordinate of a station for use in zone-to-zone transformation. 2. Entry to the nearest 0.01 meter may be made but is not required. 3. A seven-digit entry must be made to correctly define the station northing coordinate. 4. The entered value will be set to minus zero during computation with E-8 (COMP ZONE TO ZONE).
STA SPHERE	E-3	1. Depress the SM key. (KEYBOARD will light.) 2. On the keyboard, type the spheroid flag (1 to 5, depending upon the map or survey control data being used).	Depress the RECALL key. (Spheroid flag will be displayed.)	1. Used to enter the spheroid flag for use in zone-to-zone transformation. 2. Spheroid information is contained in TM 5-241-1.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
STA SPHERE	E-3 (Cont)	Flag = Spheroid 1 = Clark 1866 2 = International 3 = Clarke 1880 4 = Everest 5 = Bessel 3. Depress the ENTER key.		3. The entered value will be set to minus zero during computations with matrix function E-8 (COMP ZONE TO ZONE).
STA AZ	E-4	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the azimuth to the nearest mil. 3. Depress the ENTER key.	Depress the RECALL key. (Station azimuth will be displayed.)	1. Used to enter the station azimuth measured in the adjacent grid zone. 2. If no azimuth is reported, type 0 in step 2 of the entry procedure. 3. Entry may be to an accuracy of 0.01 mil. 4. The entered value will be set to minus zero during computations with matrix function E-8 (COMP ZONE TO ZONE).
STA ZONE	E-5	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the hemisphere designator (+ or -) and the UTM grid zone number (1 to -60). + = Northern Hemisphere - = Southern Hemisphere 3. Depress the ENTER key.	Depress the RECALL key. (Station zone will be displayed.)	1. Used to enter the UTM grid zone number of the station (target) being transformed in zone-to-zone transformation. 2. Range of input is from 1 to 60. 3. A plus or minus sign (+ or -) must precede entry of the grid zone number. 4. The entered value will be set to minus zero during computations with matrix function E-8 (COMP ZONE TO ZONE).
TRANS TO ZONE	E-6	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the hemisphere designator (+ or -) and the UTM grid zone number + = Northern Hemisphere - = Southern Hemisphere	Depress the RECALL key. (Zone number of the local zone will be displayed.)	1. Used to enter the UTM grid zone number of the zone being used for fire control. This is normally referred to as the local zone in zone-to-zone transformation. 2. Range of input is from 1 to 60.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
TRANS TO ZONE	E-6 (Cont)	3. Depress the ENTER key.		3. A plus or minus sign (+ or -) must precede entry of the grid zone number. 4. The entered value will be set to minus zero during computations with matrix function E-8 (COMP ZONE TO ZONE).
	E-7	Not used		
COMP ZONE TO ZONE	E-8	1. Depress the SM key. (KEYBOARD indicator will light.) 2. The procedure for transforming the coordinates is as follows: a. If the coordinates being transformed are those of a target location, type 1 (or any odd number) on the keyboard. (COMPUTE indicator will light and the transformed coordinates and azimuth will be displayed and automatically entered in A-1 (TGT EAST), A-2 (TGT NORTH), and A-5 (OT DIR) on matrix 1.) b. If the coordinates being transformed are those of an observer location, type 2 (or any even number) on the keyboard. (COMPUTE indicator will light and the transformed coordinates and azimuth will be displayed and automatically entered in C-1 (OBS EAST), C-2 (OBS NORTH), and C-4 (OBS DIR) on matrices 1 and 2.) Note. Before the data can be stored, altitude must be entered in A-3 (TGT ALT) on matrix 1 or C-3 (OBS ALT) on matrix 2, as appropriate. Altitude is determined from the VCO chart or is reported by the observer.	NA	1. Used to initiate the computation of a zone-to-zone transformation of UTM grid coordinates from an adjacent zone to the local zone. 2. Frequently, target locations are reported in an adjacent UTM grid zone. To compute the gun-target range and azimuth, these coordinates must be transformed to the local zone. 3. Data must have previously been entered in locations E-1 through E-6.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
STA LAT	F-1	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the hemisphere designator and the number of degrees, minutes, and seconds separated by decimal points. (See remark 3.) + = Northern Hemisphere - = Southern Hemisphere 3. Depress the ENTER key.	Depress the RECALL key. (Station latitude will be displayed.)	1. Used to enter the latitude of an observer for use in an azimuth-by-altitude computation. 2. Range of entry is from 84° south to 84° north, excluding 84°. 3. A plus or minus sign (+ or -) must precede entry of latitude. 4. A maximum of nine digits, including the decimal points and the plus or minus sign, may be entered. 5. Entry format is ±XX. XX. XX. 6. This input is required for an azimuth-by-altitude computation.
STAR ALT	F-2	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the corrected observed altitude of the star or sun preceded by a plus sign (+) if the star is east or a minus sign (-) if the star is west of the observer. 3. Depress the ENTER key.	Depress the RECALL key. (Star altitude will be displayed.)	1. Used to enter the altitude angle that has been corrected for parallax and refraction for use in an azimuth-by altitude computation. These corrections must be applied to the observed angle before this value is entered. 2. A plus or minus sign (+ or -) must precede entry of the altitude angle value.
STAR DECL	F-3	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the declination value of the star or sun to the nearest 0.01 mil preceded by a plus sign (+) for north declination or a minus sign (-) for south declination. 3. Depress the ENTER key.	Depress the RECALL key. (Star declination will be displayed.)	1. Used to enter the declination of a celestial body (the sun or a star) for use in an azimuth-by-altitude computation. 2. A plus or minus sign (+ or -) must precede entry of the declination value. 3. This entry is required for an azimuth-by-altitude computation.
HORIZ ANGLE	F-4	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the horizontal angle value from the azimuth mark to the sun or star.	Depress the RECALL key. (Horizontal angle will be displayed.)	1. Used to enter the clockwise horizontal angle from the azimuth mark to the sun or star for use in an azimuth-by-altitude computation.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
HORIZ ANGLE	F-4 (Cont)	3. Depress the ENTER key.		2. Range of entry is from 0 to 6,400 mils. 3. This input is required for an azimuth-by-altitude computation.
GRID DECL	F-5	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the grid declination value in mils preceded by a plus sign (+) if grid north is right of true north or a minus sign (-) if grid north is left of true north. 3. Depress the ENTER key.	Depress the RECALL key. (Grid declination will be displayed.)	1. Used to enter the grid declination of the observer's station for use in an azimuth-by-altitude computation. 2. A plus or minus sign (+ or -) must precede entry of grid declination value. 3. Range of entry is from 0 to $\pm$70 mils. 4. This input is required for an azimuth-by-altitude computation.
	F-6	Not used.		
	F-7	Not used.		
COMP AZ BY ALT	F-8	Depress the SM key. (COMPUTE indicator will light during computation. Grid azimuth to the nearest 0.01 mil from the station entered to the azimuth mark from which the horizontal angle was measured will be displayed.)	NA	1. Used to initiate azimuth-by-altitude computation. 2. Data must have previously been entered in F-1 through F-5. 3. Azimuth-by-altitude computation sets F-1 (STA LAT) through F-5 (GRID DECL) to minus zero.
KNPT 2 EAST	G-1	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the easting coordinate of known point 2. 3. Depress the ENTER key.	Depress the RECALL key. (Easting will be displayed.)	1. Used to enter the easting coordinate of an observer's location for use in a trilateration computation. 2. A five-digit coordinate must be used. 3. Coordinate may be entered to nearest 0.01 meter. 4. Automatic entry of data occurs when flag 2 is entered in step 4 of C-8 (POLAR PLOT KNPT).

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
KNPT 2 NORTH	G-2	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the northing coordinate of known point 2. 3. Depress the ENTER key.	Depress the RECALL key. (Northing will be displayed.)	1. Used to enter the northing coordinate of an observer's location for use in a trilateration computation. 2. A five-digit coordinate must be used. 3. Coordinate may be entered to nearest 0.01 meter. 4. Automatic entry of data occurs when flag 2 is entered in step 4 of C-8 (POLAR PLOT KNPT).
KNPT 2 ALT	G-3	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the altitude of known point 2. 3. Depress the ENTER key.	Depress the RECALL key. (Altitude will be displayed.)	1. Used to enter the altitude of known point 2 for use in a trilateration computation. If altitude is not reported, enter 0 in step 2 of the entry procedure. 2. Altitude may be entered to nearest 0.01 meter. 3. Automatic entry of data occurs when flag 2 is entered in step 4 of C-8 (POLAR PLOT KNPT). 4. Required entry for the computation of an observer location by trilateration.
AZ TO KNPT 2	G-4	1. Depress the SM key. (KEYBOARD indicator will light.) 2. Type the azimuth from the unknown observer to known point 2. 3. Depress the ENTER key.	Depress the RECALL key. (Azimuth will be displayed.)	Used to enter the unknown observer's estimated azimuth to known point 2 for use in a trilateration computation.
SLANT DIST KNPT 2	G-5	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the slant distance (measured with the laser rangefinder) from the unknown observer to known point 2. 3. Depress the ENTER key.	Depress the RECALL key. (Slant distance will be displayed.)	Used to enter the unknown observer's measured slant distance to known point 2 for use in a trilateration computation.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
VERT ANGLE [illegible]	G-6	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type a plus or minus sign (+ or -) and the value of [illegible] angle from the unknown [illegible] to known point 2. 3. Depress the ENTER key.	Depress the RECALL key. (Vertical angle will be displayed.)	1. Used to enter the unknown observer's [illegible] vertical angle to known point 2 for use in a trilateration computation. 2. A plus or minus sign (+ or -) must precede entry of the vertical angle value.
	G-7	[illegible]		
COMP TRI [illegible]	G-8	1. Prior to using this function, [illegible] appropriate data in G-1 through G-6 and H-1 through H-6. 2. Depress the SM key. (COMPUTE indicator will light during computation. Observer grid and altitude will be displayed and automatically entered in functions C-1 (OBS EAST), C-2 (OBS NORTH), and C-3 (OBS ALT)).	NA	1. Used to initiate a computation to locate [illegible] observer by using the data entered in G-1 through G-6 and H-1 through H-6.
[illegible]	[illegible]	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the easting coordinate of known point 1. 3. Depress the ENTER key.	Depress the RECALL key. (Easting will be displayed.)	1. Used to enter the easting coordinate of an observer's location for use in a trilateration computation. 2. A five-digit coordinate must be used. 3. Coordinate may be entered to nearest 0.01 meter. 4. Automatic entry of data occurs when flag 1 is entered in step 4 of C-8 (POLAR PLOT KNPT).
[illegible]	[illegible]	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the northing coordinate of known point 1. 3. Depress the ENTER key.	Depress the RECALL key. (Northing will be displayed.)	1. Used to enter the northing coordinate of an observer's location for use in a trilateration computation. 2. A five-digit coordinate must be used. 3. Coordinate may be entered to nearest 0.01 meter.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
KNPT 1 NORTH	H-2			4. Automatic entry of data occurs when flag 1 is entered in step 4 of C-8 (POLAR PLOT KNPT).
KNPT 1 ALT	H-3	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the altitude of known point 1. 3. Depress the ENTER key.	Depress the RECALL key. (Altitude will be displayed.)	1. Used to enter the altitude of known point 1 for use in a trilateration computation. If altitude is not reported, enter 0 in step 2 of the entry procedure. 2. Automatic entry of data occurs when flag 1 is entered in step 4 of C-8 (POLAR PLOT KNPT). 3. Altitude may be entered to nearest 0.01 meter. 4. Required entry for the computation of an observer location by trilateration.
AZ TO KNPT 1	H-4	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the azimuth from the unknown observer to known point 1. 3. Depress the ENTER key.	Depress the RECALL key. (Azimuth will be displayed.)	1. Used to enter the unknown observer's estimated azimuth to known point 1. 2. Required entry for the computation of an observer's location by trilateration.
SLANT DIST KNPT 1	H-5	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the slant distance (measured with laser rangefinder) from the unknown observer to known point 1. 3. Depress the ENTER key.	Depress the RECALL key. (Slant distance will be displayed.)	Used to enter the unknown observer's measured slant distance to known point 1 for use in a trilateration computation.
VERT ANGLE KNPT 1	H-6	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type a plus or minus sign (+ or -) and the value of the vertical angle from the unknown observer to known point 1. 3. Depress the ENTER key.	Depress the RECALL key. (Vertical angle will be displayed.)	1. Used to enter the unknown observer's measured vertical angle to known point 1 for use in a trilateration computation. 2. A plus or minus sign (+ or -) must precede entry of the vertical angle value.

Table G-18. Detailed Matrix 2 Functions—Continued

Matrix function	Matrix location	Entry procedure	Recall procedure	Remarks
	H-7	Not used.		
CLEAR MEMORY	H-8	1. Depress the SM key. (KEYBOARD indicator will light.) 2. On the keyboard, type the three-digit channel number. (To test the mechanical reader, use the mechanical reader diagnostic tape and type 000.) 3. Depress the ENTER key. (The COMPUTE indicator will light.) 4. Check the memory map (fig 5) and reenter necessary data.	NA	1. Used to clear a channel in working storage of memory that contains a parity as indicated by program test 2. 2. Used to check the mechanical reader. 3. Three digits must be entered in step 2. For example, the number 76 would be entered as 076. 4. Standard values are automatically reentered during the clear memory process. 5. If the mechanical reader diagnostic tape is used, a reader malfunction is indicated by a failure to read the entire tape and a display of 000 with the NO SOLUTION light flashing.

G-12. Loading The Program

a. Figure G-4 shows the signal data reproducer AN/GSQ-64 connected to the M18 gun direction computer for memory loading. Figure G-5 shows a connection diagram indicating how the specific cable connections are made. (For further details, see TM 9-1220-221-20/1.)

b. After the signal data reproducer (SDR) has been connected to the M18 gun direction computer (FADAC) refer to figure G-4 and use the procedures listed in table G-19 to load the program into memory. (For further details, see TM 9-1290-326-12.)

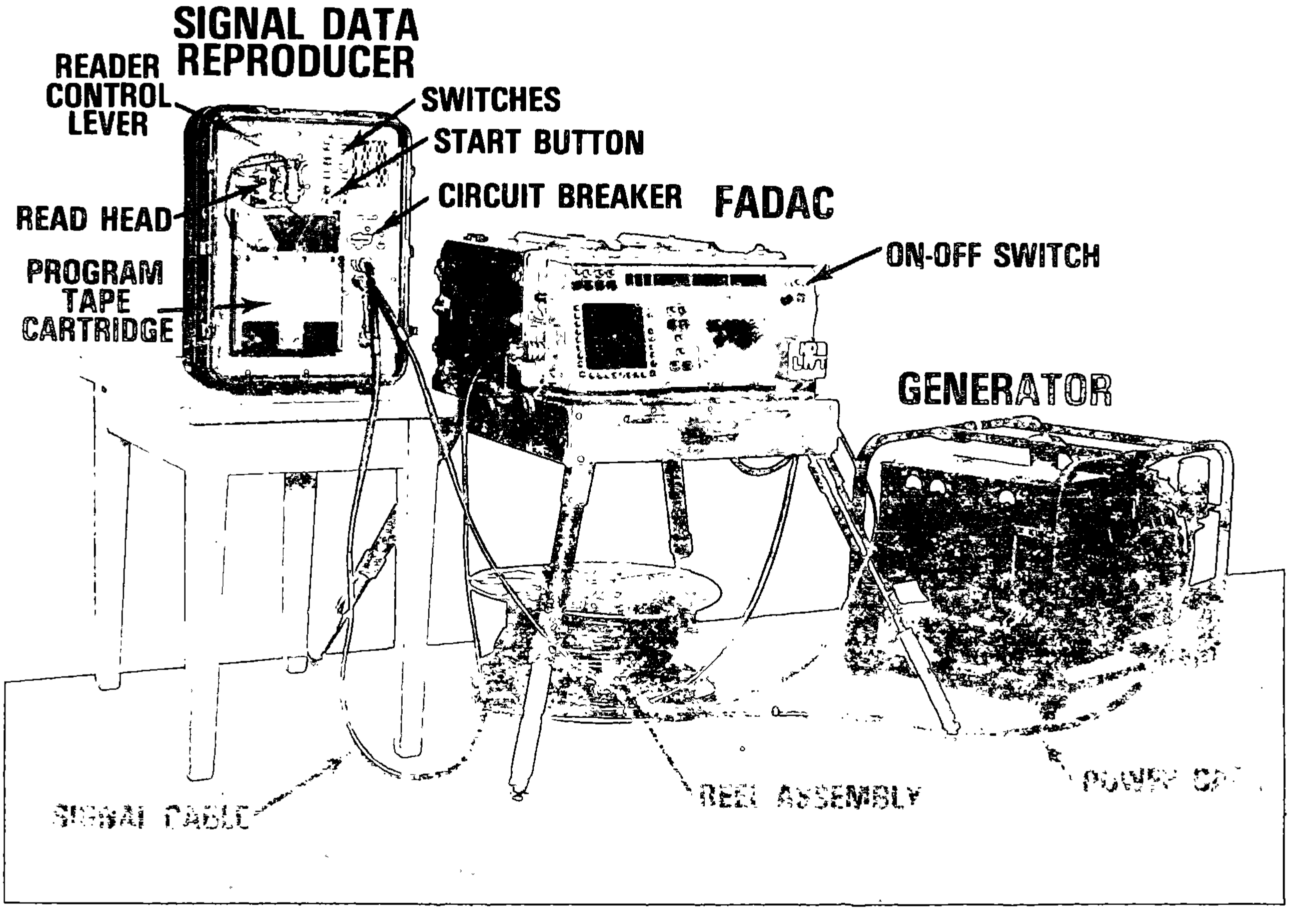

Figure G-4. The signal data reproducer connected to the FADAC for loading the program.

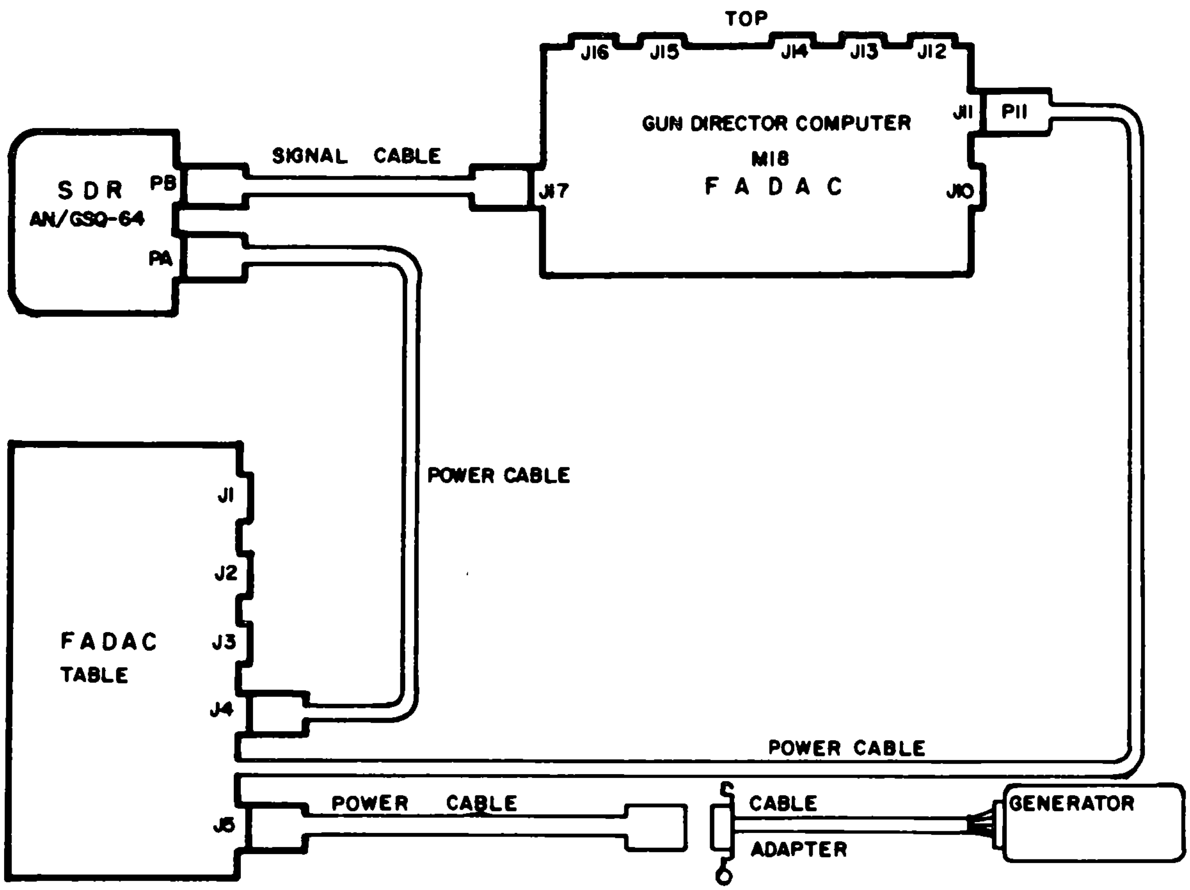

Figure G-5. Connection diagram.

Table G-19. Loading Procedures.

Step	Action
1	Remove the top of the PROGRAM TAPE CARTRIDGE and place the cartridge in the metal cannister with the wide side of the tape toward the face of the SDR. The cardboard tab on the cartridge should be in the slot of the cannister.
2	Set all SWITCHES in the down position (fig G-4) and open the READ HEAD gate.
3	Remove the cardboard tape retainer and pull three folds of tape from the top of the cartridge and thread the tape through the reader. Insure that the verify code (two small holes on the narrow side of the tape) is beyond the READ HEAD and that the first punched holes of the program tape are above the READ HEAD.
4	Turn on the SDR power by placing the CIRCUIT BREAKER in the ON position (up) and the signal switch in the ON position (up). CAUTION: Do not close the read head gate.

Table G-19. Loading Procedures

Step	Action
5	Turn on the FADAC circuit breaker and energize the FADAC by placing the ON-OFF switch in the ON position.
6	When the FADAC POWER READY indicator lights, depress the RESET button.
7	Slowly close the SDR READ HEAD gate by pressing down on the READER CONTROL LEVER while insuring that the program tape is threaded properly through the READ HEAD guides.
8	Press the START button on the SDR. The tape reader will start reading the tape. During the reading process, the FADAC IN-OUT indicator will be lit.
9	If it is necessary to stop the loading process at any time, depress the STOP button on the SDR. To restart, depress the FADAC RESET button and reload the tape as described in step 3 above and then press the START button on the SDR.
10	When the tape stops at the last code, turn off the FADAC first and then turn off the SDR. Note. This shutdown sequence is important to prevent a stray signal from affecting the program.
11.	Disconnect the signal cable from the SDR.
12.	Energize the FADAC and perform program tests 1 and 2. The successful completion of these tests will verify that the program has been loaded correctly.

APPENDIX H
SAMPLE PROBLEMS FOR REVISION FIVE CANNON TAPES

H-1. General

This appendix contains sample problems that may be used for operator training and for checking the operation of the computer. The solutions are valid for Revision 5 cannon programs. Paragraphs H-3 through H-7 are related through the known data and are designed to be solved in sequence; paragraph H-8 is an independent battery mission; paragraph H-9 is a battalion mission, but known data are applicable to paragraphs H-10 and H-11. Paragraphs H-12 through H-15 pertain to solution of survey problems using matrix 2. Check the Nixie display after typing in data to verify accuracy. Assume that fire orders are set to standard as referenced in FM 6-40-5.

H-2. Setup and Testing

a. Perform Program Tests 1 through 3 (para G-3).

b. Perform setup procedures for matrix function E-2 (SET UP) (table G-17) for each battery.

c. Set MET to standard for all batteries by enabling H-6 (MET STD) and entering 0.

H-3. Battery Adjust Fire Mission — Grid — (PD/Q)

a. Known Data.

(1) Map-inspected coordinates of battery center: 4349 3437.

(2) Altitude: 409 meters.

(3) Azimuth of lay: 60 mils.

(4) Referred deflections:

105-mm M101A1	2800
105-mm M102, M108	3200
155-mm M114A1	2400
155-mm M109, M109A1	3200
8-inch M110	3200
175-mm M107	3200

(5) Muzzle velocity and meteorological data: Standard.

(6) Powder temperature: +69° F.

(7) Projectile weight: Standard.

(8) Latitude: 34° North.

(9) Grid declination: +18 (East).

Table H-1. Entry of Known Data

Step	Activate button-matrix location	Activate button or type-keyboard location
1	Battery A button	
2	H-1(BTRY EAST)	SM; 43490; ENTER
3	H-2(BTRY NORTH)	SM; 34370; ENTER
4	H-3(BTRY ALT)	SM; 409; ENTER
5	H-4(BTRY AZ LAID)	SM; 60; ENTER
6	H-5(BTRY DF)	SM; Type and check referred deflection of the caliber and type of weapon used (para H-3a(4)).
7	G-2(POWD TEMP)	SM; +69; ENTER
8	G-4(LAT)	SM; +34; ENTER
9	G-5(GRID DECL)	SM; +18; ENTER

NOTE: The projectile weight and muzzle velocity functions have been set to standard during the setup procedures (para H-2); no entries are required for these elements at this time. The LAT and GRID DECL need only be entered for one battery when more than one battery is being entered.

b. Fire Mission and Fire Order.

(1) CALL FOR FIRE: *B26 THIS IS B32, ADJUST FIRE, OVER. GRID 445433, OVER. SURVEY PARTY IN THE OPEN, OVER.*

(2) FIRE ORDER: *ALFA, TWO ROUNDS.*

(3) VCO DATA: *TARGET ALTITUDE, 435 METERS.*

Table H-2. Battery Adjust Fire Mission — Grid — (PD/Q)

☐ Task	Step	Activate button-matrix location	Activate button or type-keyboard location
☐ ***ENTER TARGET LOCATION AND FIRING DATA***			
	1	Battery A button	
	2	A-1(TGT EAST)	SM; 44500; ENTER
	3	A-2(TGT NORTH)	SM; 43300; ENTER

NOTE: Five digits must be entered in A-1 and A-2 to close keyboard.

	4	A-3(TGT ALT)	SM; 435; ENTER

NOTE: Fire order required no overrides.

	5	COMPUTE	

DISPLAY

	CHG	*DF*	*TOF*	*QE*
105-mm M101A1	7	2755	31.0	437
105-mm M102, M108	7	3156	29.8	400
155-mm M114	6	2353	29.0	385
155-mm M109	6	3156	29.1	390
155-mm M109A1	6	3157	28.2	368
8-inch M110	6	3153	25.9	310
175-mm M107	1	3151	24.5	275

NOTE: Depress the RECEIVE button to erase the leading zeros.

OBSERVER CORRECTION: *DIRECTION 6200, RIGHT 180.*

☐ ***ENTER OBSERVER CORRECTIONS***

	6	B-1(CHG)	SM; 6; ENTER

NOTE: Type in charge of last firing data to prevent computer from changing charges.

	7	A-5(OT DIR)	SM; ENTER CHARGE OF INITIAL FIRING DATA
	8	A-6(RIGHT/LEFT)	SM; RIGHT 180; ENTER
	9	TRIG	

DISPLAY

	CHG	DF	TOF	QE
105-mm M101A1	7	2736	31.3	442
105-mm M102, M108	7	3137	30.1	404
155-mm M114	6	2334	29.2	389
155-mm M109	6	3137	29.4	394
155-mm M109A1	6	3138	28.4	371
8-inch M110	6	3134	26.1	313
175-mm M107	1	3131	24.7	278

OBSERVER CORRECTION: *ADD 200.*

☐ ***ENTER OBSERVER CORRECTIONS***

10	A-7(ADD/DROP)	SM; ADD 200; ENTER
11	TRIG	

DISPLAY

	CHG	DF	TOF	QE
105-mm M101A1	7	2743	32.3	458
105-mm M102, M108	7	3144	31.0	419
155-mm M114	6	2341	30.1	402
155-mm M109	6	3145	30.2	407
155-mm M109A1	6	3145	29.3	384
8-inch M110	6	3141	26.8	323
175-mm M107	1	3139	25.4	287

OBSERVER CORRECTION: *DROP 100, FIRE FOR EFFECT.*

☐ ***ENTER OBSERVER CORRECTIONS***

12	A-7(ADD/DROP)	SM; DROP 100; ENTER
13	TRIG	

DISPLAY

	CHG	DF	TOF	QE
105-mm M101A1	7	2740	31.8	450
105-mm M102, M108	7	3141	30.6	411
155-mm M114	6	2338	29.7	395
155-mm M109	6	3141	29.8	400
155-mm M109A1	6	3142	28.8	377
8-inch M110	6	3138	26.5	318
175-mm M107	1	3135	25.0	282

OBSERVER SURVEILLANCE: *END OF MISSION, THREE CASUALTIES*

☐ ***TERMINATE THE MISSION***

	14	E-1(EOM)	SM; 0

H-4. Storage of Targets

a. Known Data (table H-1). Following target data is available:

TGT	*GRID*	*ALT*
AB401	455433	396
AB402	366425	409

b. FDO Directive. STORE TARGETS AB401 AND AB402 IN FILE NUMBERS THREE AND FOUR.

NOTE: Insure that Battery A button is depressed.

Table H-3. Storage of Target Locations

☐ Task	Step	Activate button-matrix location	Activate button or type-keyboard location
☐ ***STORE TARGET IN FILE 3***			
	1	A-1(TGT EAST)	SM; 45500; ENTER
	2	A-2(TGT NORTH)	SM; 43300; ENTER
	3	A-3(TGT ALT)	SM; 396; ENTER
NOTE: Type designated number (1-128) for use as the target (in this case, 3).			
	4	E-3(TGT STORE)	SM; 3; ENTER
45500 43300 00396			
☐ ***STORE TARGET IN FILE 4***			
	5	Repeat steps 1 through 4 for target AB402 using file number 4 to store the target.	

H-5. Battery Adjust Fire Mission — Shift From Known Point (PD/VT)

a. Known Data (table H-1).

b. Fire Mission and Fire Order.

(1) CALL FOR FIRE: *B26 THIS IS B32, ADJUST FIRE, SHIFT, AB401, OVER, DIR 6200, LEFT 100, ADD 200, UP 50, OVER COMBAT OP IN OPEN, VT IN EFFECT, OVER.*

(2) MESSAGE TO OBSERVER: *ALFA, TWO ROUNDS*

NOTE: AB401 is stored in file number 3.

Table H-4. Battery Adjust Fire Mission — Shift from Known Point (PD/VT)

☐ Task	Step	Activate button-matrix location	Activate button or type-keyboard location
☐ *SELECT PROPER BATTERY*			
	1	Battery A button	
☐ *RECALL TARGET*			
	2	A-4(TGT RECALL)	SM; 3; ENTER

45500 43300 00396

☐ Task	Step	Activate button-matrix location	Activate button or type-keyboard location
☐ *DETERMINE FIRING DATA FOR NEW TARGET*			
	3	A-5(OT DIR)	SM; 6200; ENTER
	4	A-6(RIGHT/LEFT)	SM; LEFT 100; ENTER
	5	A-7(ADD/DROP)	SM; ADD 200; ENTER
	6	A-8(UP/DOWN)	SM; UP 50; ENTER
	7	COMPUTE	

DISPLAY

	CHG	DF	TOF	QE
105-mm M101A1	7	2664	32.7	465
105-mm M102, M108	7	3065	31.3	425
155-mm M114	7	2261	25.6	280
155-mm M109	7	3063	25.9	287
155-mm M109A1	6	3066	29.5	389
8-inch M110	6	3062	27.1	328
175-mm M107	1	3059	25.6	291

OBSERVER CORRECTION: *DROP 100.*

☐ ***ENTER OBSERVER CORRECTIONS***

8	B-1(CHG)	SM; charge of fired data; ENTER
9	A-7(ADD/DROP)	SM; DROP 100; ENTER
10	TRIG	

DISPLAY

	CHG	*DF*	*TOF*	*QE*
105-mm M101A1	7	2659	32.2	457
105-mm M102, M108	7	3060	30.9	418
155-mm M114	7	2256	25.2	276
155-mm M109	7	3058	25.5	283
155-mm M109A1	6	3061	29.1	383
8-inch M110	6	3058	26.7	323
175-mm M107	1	3055	25.3	287

OBSERVER CORRECTION: *ADD 50 FIRE FOR EFFECT.*

☐ ***ENTER OBSERVER CORRECTIONS***

11	A-7(ADD/DROP)	SM; ADD 50; ENTER

☐ ***ENTER OVERRIDES IN B ROW***

NOTE: Type proper flag for VT fuze (tables G-2 through G-5).

12	B-6(FUZE TYPE)	SM; 3; ENTER
13	COMPUTE	

DISPLAY

	CHG	*DF*	*TI*	*QE*
105-mm M101A1	7	2662	32.0	464
105-mm M102, M108	7	3063	31.0	424
155-mm M114	7	2258	25.0	280
155-mm M109	7	3061	25.0	287
155-mm M109A1	6	3064	29.0	388
8-inch M110	6	3060	26.0	328
175-mm M107	1	3057	25.0	291

OBSERVER SURVEILLANCE: *END OF MISSION (reports surveillance)*

☐ ***TERMINATE THE MISSION***

14	E-1(EOM)	SM; 0

H-6. Battery Adjust Fire Mission — Polar Plot — (PD/TI, Replot)

a. Known Data.

(1) Battery (table H-1).

(2) Observer:

CALL SIGN	*OBSERVER*	*COORDINATES*	*ALTITUDE*	*STORE*
B32	01	49150 40250	510	1
B19	02	50012 39986	483	2
B64	03	47500 44650	465	3

Table H-5. Entry of Observer Data

Step	Activate button-matrix location	Activate button or type-keyboard location
1	C-1(OBS EAST)	SM; 49150; ENTER
2	C-2(OBS NORTH)	SM; 40250; ENTER
3	C-3(OBS ALT)	SM; 510; ENTER

NOTE: Type the number (1 through 18) assigned to the observer.

4	D-3(OBS STORE)	SM; 1; ENTER

49150 40250 00510

5	Repeat steps 1 through 4 for remaining observers.	

b. Fire Mission and Message to Observer.

(1) CALL FOR FIRE: *B26 THIS IS B32, ADJUST FIRE, POLAR, OVER DIRECTION 4000, DISTANCE 1800, OVER INFANTRY COMPANY IN OPEN, TIME IN EFFECT, OVER*

(2) MESSAGE TO OBSERVER: *ALFA, THREE ROUNDS.*

NOTE: B32 is filed as observer 1.

Table H-6. Battery Adjust Fire Mission — Polar Plot (PD/TI, Replot)

☐ Task	Step	Activate button-matrix location	Activate button or type-keyboard
☐ *SELECT PROPER BATTERY*			
	1	Battery A button	
☐ *POLAR PLOT TARGET LOCATION*			
	2	D-4(OBS RECALL)	SM; 1; ENTER

49150 40250 00510

	3	C-4(OBS DIR)	SM; 4000; ENTER
	4	C-5(OBS HORIZ DIST)	SM; 1800; ENTER

NOTE: When FO is equipped with one laser rangefinder, C-6 (OBS SLANT DIST) is used.

	5	C-7(OBS VERT ANGLE)	SM; +0; ENTER

NOTE: This is a survey function requiring a VA entry.

	6	C-8(POLAR PLOT TGT)	SM

47877 38977 00510

NOTE: The target grid and altitude will be displayed and automatically stored in matrix positions A-1, A-2, and A-3.

☐ *OBTAIN FIRING DATA TO TARGET LOCATION*

7 COMPUTE

DISPLAY

	CHG	*DF*	*TOF*	*QE*
105-mm M101A1	6	2091	22.7	368
105-mm M102, M108	6	2492	21.9	340
155-mm M114	5	1690	21.7	339
155-mm M109	5	2493	21.7	340
155-mm M109A1	5	2493	21.5	337
8-inch M110	4	2491	21.9	352
175-mm M107	1	2488	15.7	181

OBSERVER CORRECTION: *TIME, LEFT 40, ADD 50.*

☐ *ENTER OBSERVER CORRECTIONS*

8	B-1(CHG)	SM; charge of initial firing data; ENTER
9	B-6(FUZE TYPE)	SM; flag for TI fuze (tables G-2 through G-5); ENTER

NOTE: 175-mm gun will fire PD fuze.

10	A-6(RIGHT/LEFT)	SM; LEFT 40; ENTER
11	A-7(ADD/DROP)	SM; +50; ENTER
12	TRIG	

DISPLAY

	CHG	*DF*	*TI*	*QE*
105-mm M101A1	6	2085	22.7	368
105-mm M102, M108	6	2486	22.0	340
155-mm M114	5	1684	21.4	340
155-mm M109	5	2486	21.4	341
155-mm M109A1	5	2487	21.2	338
8-inch M110	4	2484	21.4	352
175-mm M107(HE-PD)	1	2482	15.6(TOF)	179(Go to step 15).

OBSERVER CORRECTION: *UP 20, FIRE FOR EFFECT.*

☐ *ENTER OBSERVER CORRECTIONS*

13	A-8(UP/DOWN)	SM; 20; ENTER
14	TRIG	

DISPLAY

	CHG	*DF*	*TI*	*QE*
105-mm M101A1	6	2085	22.5	368
105-mm M102, M108	6	2486	21.8	340
155-mm M114	5	1684	21.2	340
155-mm M109	5	2486	21.2	341
155-mm M109A1	5	2487	21.0	338
8-inch M110	4	2484	21.2	352

OBSERVER SURVEILLANCE: *LEFT 10, ADD 20, RECORD AS TARGET, END OF MISSION.*

☐ *REPLOT THE TARGET*

NOTE: Replot procedures are the same for fuze Q, TI, and VT.

15	A-6(RIGHT/LEFT)	SM; LEFT 10; ENTER
16	A-7(ADD/DROP)	SM; +20; ENTER
17	COMPUTE	

DISPLAY

	CHG	*DF*	*TI*	*QE*
105-mm M101A1	6	2084	22.4	367
105-mm M102, M108	6	2484	21.7	339
155-mm M114	5	1682	21.1	338
155-mm M109	5	2485	21.1	339
155-mm M109A1	5	2485	21.0	337
8-inch M110	4	2483	21.1	351
175-mm M107	1	2480	15.5	179

18	D-8(REPLOT RECT)	SM

NOTE: The coordinates and altitude used to establish the trajectories that hit the target will be displayed and the KEYBOARD and IN/OUT light will remain on.

47863 38892 00510

FADAC OPERATOR ANNOUNCES TO THE VCO: *GRID 47863 38892, ALTITUDE 510.*

VCO PLOTS ANNOUNCED GRID ON HIS MAP, DETERMINES GRID ALTITUDE, AND ANNOUNCES *"ALTITUDE 515." (CONTOUR INTERVAL IS 10 METERS.)*

NOTE 1. If VCO altitude compares to FADAC altitude exactly or is within plus or minus one-half the value of one contour interval, the VCO altitude becomes the REPLOT ALTITUDE announced to the FADAC operator. Proceed to step 19 and enter announced replot altitude.

NOTE 2. If VCO altitude does not agree within plus or minus one-half contour interval, the VCO announces to the FADAC operator, *"ALTITUDE ______."* Proceed to step 19, but repeat the comparison of altitudes in Note 1 until the replot altitude is within tolerances.

☐ ***DETERMINE REPLOT GRID***

19	515; ENTER

DISPLAY		
WEAPON	*REPLOT GRID*	*REPLOT ALTITUDE*
M102, M108	47854 38883	515
M109A1	47858 38887	515
M101A1	47859 38888	515
M109, M110	47856 38885	515
M107	47846 38875	515
M110, M114	47854 38883	515

☐ ***TERMINATE THE REPLOT GRID***

20 .(decimal); ENTER

NOTE: Replot grid and altitude are transferred to A-1, A-2, and A-3. (Display is for M109A1.)

47858 38887 00515

NOTE: KEYBOARD and IN/OUT lights remain lighted.

FDO TO FADAC OPERATOR: *STORE THIS TARGET IN FILE TEN.*

☐ ***STORE THE TARGET IN DESIGNATED LOCATION***

21 E-3(TGT STORE) SM; 10; ENTER

47858 38887 00515

☐ ***TERMINATE THE MISSION***

22 E-1(EOM) SM; 0

H-7. Receipt and Entry of a MET Message

MET MESSAGE

INTRODUCTION

Identification	Octant	Location	Date-Time	Station Height (10'sm)	MDP Pressure
METCM	1	361320	261650	036	987 (mbs)

BODY

Line Number	Wind Direction (10's mils)	Wind Speed (knots)	Temperature (1/10°K)	Pressure (mbs)
00	010	011	2693	0987
01	048	019	2679	0974
02	032	014	2673	0954
03	056	037	2617	0898
04	014	015	2672	0838
05	540	014	2710	0793
06	512	022	2707	0741
07	516	033	2672	0692
08	504	060	2672	0649
09	492	070	2657	0612
10	491	065	2616	0573
11	490	060	2580	0537
12	485	050	2542	0485
13	475	055	2483	0425
14	480	052	2410	0639
15	490	055	2327	0319
16	500	060	2248	0276
17	550	058	2192	0226
18	601	036	2141	0202
19	614	035	2106	0172
20	587	032	2119	0144

Table H-7. Entry of MET Message

☐ Task	Step	Activate button-matrix location	Activate button or type-keyboard location
☐ *ENTER DATA*			
	1	H-6(MET STD)	SM; 9
	2	E-4(INPUT MET MSG)	SM; 0 (manual input); ENTER SM; 1 (paper tape); ENTER

NOTE: The number 88 will appear in display window in the manual input.

	3	Beginning with DATE-TIME group of instruction, type in 12-digit introduction.	
			261650036987; ENTER

	4	Type 00 line.	00 010 011 2693 0987; ENTER

00

	5	Repeat step 4 for number of lines to be entered.	

NOTE: All FADAC systems should enter 14 lines of MET except for the 175-mm gun, which uses 20 lines.

☐ *TERMINATE THE PROCEDURE*			
	6		9

H-8. High Burst Registration

a. Known Data.

(1) Battery center: 44095 36120

(2) Altitude: 389 meters

(3) Azimuth of lay: 6400

(4) Referred deflection: (para H-3a(4))

(5) Met data (para H-7) remains current

(6) Muzzle velocity data: unknown

(7) Powder temperature: +60° F.

(8) Projectile weight: Standard

(9) Latitude and grid declination: unchanged

b. S3 Instructions. FIRE A HIGH BURST REGISTRATION, HEIGHT OF BURST 50 METERS, ON GRID INTERSECTION 5044. 175-MM FIRE MPI REGISTRATION. REGISTRATION POINT ALTITUDE IS 457 METERS.

Table H-8. High Burst Registration

☐ Task	Step	Activate button-matrix location	Activate button or type-keyboard location
☐ *ENTER KNOWN DATA*			
	1	Perform essential portions of table H-1 for Battery D.	
☐ *ENTER GRID OF REGISTRATION POINT*			
	2	Battery D button	
	3	A-1(TGT EAST)	SM; 5000; ENTER
	4	A-2(TGT NORTH)	SM; 44000; ENTER
	5	A-3(TGT ALT)	SM; 507; ENTER SM; 457; ENTER (175-mm)

NOTE: Height of burst is added to altitude of registration point.

+50000 44000 00507

☐ ***DETERMINE ORIENTING DATA FOR THE OBSERVERS***

NOTE: Observers 1 and 2 will be used and should have already been stored as indicated in table H-5.

6	D-4(OBS RECALL)		SM; 1; ENTER	
	49150 40250 00510			
7			SM; 2; ENTER	
	50012 39986 00483			
8	D-2(ORIENT)		SM	
	02			

NOTE: The orienting data for the last observer recalled will be shown first when ENTER is depressed.

9			ENTER	
	6397	4014		6
	6397	4014	9	7 (175-mm)

NOTE: A 9 in the VERTICAL ANGLE window indicates negative value.

10			ENTER	
	01			
11			ENTER	
	227	3845	9	1
	227	3845	9	4 (175-mm)

☐ ***DETERMINE FIRING DATA TO REGISTRATION POINT***

12 B-1(CHG) SM; selected charge; ENTER

CALIBER	*CHARGE*
105-mm	7
155-mm	7
8-inch	6
175-mm	1

13 B-6(FUZE TYPE) SM; flag number for fuze TI (tables G-2 through G-5). 175-mm use fuze PD; ENTER

14 A-3(TGT ALT) RECALL

+00507

NOTE: Subtract 20 meters from HB altitude to compensate for 20/R and enter new resultant altitude prior to computing firing data (507-20).

15 SM; 487; ENTER

16 COMPUTE

DISPLAY

	CHG	*DF*	*TI*	*QE*
105-mm M101A1	7	2165	39.9	595
105-mm M102, M108	7	2565	37.9	530
155-mm M114	7	1757	29.4	344
155-mm M109	7	2559	29.9	352
155-mm M109A1	7	2560	29.5	343
8-inch M110	6	2558	30.6	394
175-mm M107	1	2554	29.1(TOF)	344

NOTE: This data is the only data required to fire the HB registration. The mission can be terminated after the observers see the first round.

☐ ***TERMINATE THE MISSION***

17 Perform applicable portion of table H-1.

NOTE: The direction and vertical angles from six usable rounds are averaged:
01: direction 176, vertical angle +10; 02: direction 6325

☐ ***ENTER DATA FOR OBSERVERS***

18 Battery D button

19 D-4(OBS RECALL) SM; 1; ENTER

49150 40250 00510

20 C-4(OBS DIR) SM; 176; ENTER

21 C-7(OBS VERT ANGLE) SM; +10; ENTER

22 D-4(OBS RECALL) SM; 2; ENTER

50012 39986 00483

23 C-4(OBS DIR) SM; 6325; ENTER

☐ ***DISPLAY GRID OF HIGH BURST***

24	D-1(LOCATE)	SM

49742 43643 00545

NOTE: Grid and altitude of HB displayed and automatically transferred to A-1, A-2, and A-3.

☐ *DETERMINE THE REGISTRATION CORRECTIONS (RESIDUALS) AND APPLY THEM TO BATTERY D ONLY (REGISTERING PIECE OVER BATTERY CENTER)*

NOTE: Enter appropriate overrides (tables G-2 through G-5) in steps 25 through 28 below. 175-mm perform step 25, disregard steps 26 through 28.

25	B-1(CHG)	SM; last fired; ENTER

NOTE: Steps 26 and 27 are normally omitted because this is a low angle mission.

26	B-2(HI ANGLE)	SM; 0 (yes) or 9 (no); ENTER
27	B-3(WHITE BAG)	SM; 0 (yes) or 9 (no); ENTER
28	B-6(FUZE TYPE)	SM; appropriate flag (tables G-2 through G-5); ENTER
29	G-6(DF INPUT)	SM; adjusted DF (step 16); ENTER

NOTE: 175-mm disregard step 30.

30	G-7(TIME INPUT)	SM; adjusted TI (step 16); ENTER
31	G-8(QE INPUT)	SM; adjusted QE (step 16); ENTER
32	H-8(COMP REG); COMPUTE	When firing data are displayed, SM

NOTE: Negative values are indicated by a 9 in the window.

	DISPLAY		
	DF	*FZ*	*RG K*
105-mm M101	L(-)2	+2	+42
105-mm M102, M108	L(-)2	+.2	+42
155-mm M114	L(-)2	+.3	+40
155-mm M109	L(-)1	+.2	+40
155-mm M109A1	L(-)1	+.3	+39
8-inch M110	L(-)2	+.3	+40
175-mm M107	L(-)1	0.0	+28

☐ *STORE THE RESIDUALS*	
33	Charge fired for HB (step 16); ENTER
☐ *TERMINATE THE MISSION*	
34	.(decimal); ENTER

H-9. Battalion Mission — Mass Fires — (PD/ICM)

a. Situation. Battalion has occupied positions; battalion survey has been completed.

b. Known Data.

	A Battery	*B Battery*	*C Battery*
(1) Grid	4341734300	4450634682	4316235203
(2) Altitude	406	395	398
(3) Direction Fire	60	100	170
(4) Latitude	34° N	34° N	34° N
(5) Grid declination	+18 mils	+18 mils	+18 mils
(6) Deflection (table H-3a(4))			

Table H-9. Entry of Known Data for Battalion

☐ Task	Step	Activate button-matrix location	Activate button or type-keyboard location
☐ *ENTER BATTERY A DATA*			
	1	Battery A button	
	2	H-1(BTRY EAST)	SM; 43417; ENTER
	3	H-2(BTRY NORTH)	SM; 34300; ENTER
	4	H-3(BTRY ALT)	SM; 406; ENTER
	5	H-4(BTRY AZ LAID)	SM; 60; ENTER
	6	H-5(BTRY DF)	SM; referred deflection (para H-3a(4)); ENTER
	7	G-4(LAT)	SM; +34; ENTER

8	G-5(GRID DECL)	SM; +18; ENTER

NOTE: The latitude and the grid declination angle need not be entered for the other batteries since they are computer associated functions. Their entry for one battery suffices for all batteries.

☐ *ENTER BATTERY B DATA*

9 Repeat steps 1 through 8 by depressing Battery B button and entering Battery B data.

☐ *ENTER BATTERY C DATA*

10 Repeat steps 1 through 8 by depressing Battery C button and entering Battery C data.

☐ *CLEAR COMPUTER OF A OVERRIDES*

11	Battery A button; E-1(EOM)	SM; 0

☐ *CLEAR COMPUTER OF B OVERRIDES*

12 Battery B button, repeat step 11.

☐ *CLEAR COMPUTER OF C OVERRIDES*

13 Battery C button, repeat step 11.

c. *Additional Known Data.*

(1) The current MET message (para H-7) is valid.

(2) Muzzle velocity — shell HE, Lot R (105), WT (155-mm, 8-in, 175-mm) shell WP, PZ (155).

		A	*B*	*C*
105	CHG 6	359.6	375.4	356.2
	CHG 7	457.8	456.1	454.9
155	CHG 5	370.0	368.2	367.1
	CHG 6	460.2	459.1	457.6
MV-WP	CHG 5 WB	386.1	382.6	381.6
8-inch	CHG 5	417.6	414.6	412.0
	CHG 6	495.0	490.9	488.0
175	CHG 1	498.1	505.0	496.2

(3) Powder temperature: +64° F +62° F +63° F

(4) Projectile weights:

105	Shell HE	33.6	33.6	34.2
	Shell WP	35.4	35.4	35.4
155	Shell HE	93.9	96.1	97.2
	Shell WP	(97.2)	(98.3)	(96.1)
8-inch	Shell HE	200.0	202.5	205.0
175	Shell HE	148.9	150.0	150.0

NOTE: Following solution is for 105-mm.

☐ *ENTER BATTERY A MUZZLE VELOCITY, POWDER TEMPERATURE, AND PROJECTILE WEIGHTS*

14	Battery A button	

☐ *ENTER ALL WHITE BAG DATA*

15	B-3(ENABLE WHITE BAG)	SM
16	G-1(MV)	SM; HE charge 6 shell-charge combination (16) (KEYBOARD light remains lighted); ENTER
		Type muzzle velocity (359.6); ENTER
17		SM; HE charge 7 shell-charge combination (17) (KEYBOARD light remains lighted); ENTER
		Type muzzle velocity (457); ENTER

☐ *TERMINATE WHITE BAG MODE*

18	B-3(ENABLE WHITE BAG)	SM; 9

☐ *ENTER ALL GREEN BAG DATA*

19	Repeat steps 16 and 17 as required.	

☐ *ENTER POWDER TEMPERATURE AND PROJECTILE WEIGHT*

20	G-2(POWD TEMP)	SM; +64; ENTER
21	G-3(PROJ WT)	SM; HE code (1); ENTER (KEYBOARD light remains lighted)
		Type HE projectile weight (33.6); ENTER
22		SM; WP code (2); ENTER (KEYBOARD light remains lighted)
		Type WP projectile weight (35.4); ENTER

☐ *ENTER BATTERY B MUZZLE VELOCITY, POWDER TEMPERATURE, AND PROJECTILE WEIGHTS*

23	Battery B button, repeat applicable portions of steps 16 through 21.	

☐ *ENTER BATTERY C MUZZLE VELOCITY, POWDER TEMPERATURE, AND PROJECTILE WEIGHTS*

24 Battery C button, repeat applicable portions of steps 16 through 21.

NOTE: The data entered in the computer at this time meet the requirements for accurate, unobserved, surprise fire using the shell and the propellant charges for which the muzzle velocity had been entered. The computer has the capability of massing the fires of Batteries A, B, and C on a target.

d. Fire Mission and Fire Order.

(1) CALL FOR FIRE: *B26 THIS IS B32, ADJUST FIRE, OVER, GRID 463 423, BATTALION ASSEMBLY AREA, OVER, ICM IN EFFECT, OVER*

NOTE: 155-mm uses M449 round.

(2) VCO ANNOUNCES: *ALTITUDE 400*

(3) S3 FIRE ORDER: *BATTALION, ALFA, FOUR ROUNDS*

e. Current Residuals: DF CORR L2, FZ CORR +0.2, RANGE K +42

NOTE: 175-mm fires HE only, so HE residuals must be entered first (steps 37 through 43).

Table H-10. Battalion Mission — Mass Fires (PD/ICM)

☐ Task	Step	Activate button-matrix location	Activate or type-keyboard location
☐ *PROCESS THE MISSION FOR THE ADJUSTING BATTERY (A)*			
	1	Battery A button	
	2	A-1(TGT EAST)	SM; 46300; ENTER
	3	A-2(TGT NORTH)	SM; 42300; ENTER
	4	A-3(TGT ALT)	SM; 400; ENTER
☐ *ENTER RESIDUALS*			

NOTE: Enter residuals using following charges:

WPN	*CHARGE*
105-mm	7
155-mm	6
8-inch	5
175-mm	1

	5	F-6(DF CORR)	SM; appropriate charge; ENTER; Type deflection correction; ENTER
	6	F-7(TIME CORR)	SM; appropriate charge; ENTER; Type fuze correction; ENTER

7 F-8(RANGE/K) SM; appropriate charge; ENTER; Type range K; ENTER

☐ ***OBTAIN SOLUTION TO ADJUSTING POINT FOR BATTERY A***

8 COMPUTE

DISPLAY	*CHG*	*DF*	*TOF*	*QE*
105-mm M101A1	7	2520	33.4	490
155-mm M102, M108	7	2923	33.6	492
155-mm M114	6	2117	30.5	415
155-mm M109	6	2921	30.6	418
155-mm M109A1	6	2922	30.3	415
8-inch M110	5	2918	31.2	452
175-mm M107	1	2914	26.1	303

9 B-1(CHG) SM; appropriate charge; ENTER

NOTE: The number 2 represents Battery B; number 3 represents Battery C.

☐ ***MASS FIRES***

10 B-8(MASS FIRE) SM; 23; ENTER

11 Battery B button

12 B-1(CHG) SM; appropriate charge (step 8); ENTER

NOTE: 175-mm operator proceed to step.

13 B-5(PROJ TYPE) SM; appropriate ICM flag as indicated:

WEAPON	*SHELL*	*FLAG*
105-mm	M444	6
155-mm	M449	6
	M449A1	7
	M449E1	8
8-inch	M404	6
175-mm	M437	1

14 B-6(FUZE TYPE) SM; appropriate flag for time fuze (tables G-2 through G-5); ENTER

☐ ***ENTER ICM RESIDUALS FOR BATTERY B***

15 F-6(DF CORR) SM; appropriate charge (step 8); ENTER; Deflection correction; ENTER

16	F-7(TIME CORR)	SM; appropriate charge (step 8); ENTER Fuze correction; ENTER

NOTE: Range K value must be entered if corrections for deflection and/or time have been entered in F-6 and/or F-7.

17	F-8(RANGE/K)	SM; appropriate charge (step 8); ENTER; Range K; ENTER

☐ ***OBTAIN SOLUTION TO ADJUSTING POINT FOR BATTERY B***

18 COMPUTE

DISPLAY

	BTRY	*CHG*	*DF*	*TI*	*QE*
105-mm M101A1	B	7	2671	29.9	466
105-mm M102, M108	B	7	3071	28.7	423
155-mm M114A1	B	6	2268	26.3	392
155-mm M109	B	6	3071	26.5	396
155-mm M109A1	B	6	3071	25.9	381
8-inch M110	B	5	3070	27.5	432
175-mm M107	B	1	3069	22.9(TOF)	259

☐ ***OBTAIN SOLUTION TO ADJUSTING POINT FOR BATTERY C***

19 Depress the Battery C button and repeat steps 12 through 18.

DISPLAY

	BTRY	*CHG*	*DF*	*TI*	*QE*
105-mm M101A1	C	7	2557	29.5	460
105-mm M102, M108	C	7	2957	28.4	417
155-mm M114A1	C	6	2154	26.0	387
155-mm M109	C	6	2957	26.2	392
155-mm M109A1	C	6	2957	25.6	377
8-inch M110	C	5	2955	27.2	426
175-mm M107	C	1	2953	22.1(TOF)	266

OBSERVER CORRECTION: *DIRECTION 5400, LEFT 140, ADD 50, FIRE FOR EFFECT*

☐ ***OBTAIN ADJUSTMENT DATA FOR BATTERY A***

20	Battery A button	
21	A-5(OT DIR)	SM; 5400; ENTER
22	A-6(RIGHT/LEFT)	SM; LEFT 140; ENTER

23	A-7(ADD/DROP)	SM; ADD 50; ENTER

NOTE: 175-mm proceed to step 26.

24	B-5(PROJ TYPE)	SM; appropriate ICM flag (step 13); ENTER
25	B-6(FUZE TYPE)	SM; appropriate flag for time fuze (tables G-2 through G-5); ENTER

☐ ***ENTER ICM RESIDUALS***

26	F-6(DF CORR)	SM; appropriate charge (step 8); ENTER; Deflection correction; ENTER
27	F-7(TIME CORR)	SM; appropriate charge (step 8); ENTER; fuze correction; ENTER

NOTE: Range K must be entered if corrections for deflection and/or time have been entered in F-6 or F-7.

28	F-8(RANGE/K)	SM; appropriate charge (step 8); ENTER Range K; ENTER

☐ ***OBTAIN FIRE FOR EFFECT DATA FOR BATTERY A***

29 TRIG

DISPLAY

	BTRY	*CHG*	*DF*	*TI*	*QE*
105-mm M101A1	A	7	2530	33.0	512
105-mm M102, M108	A	7	2930	31.6	461
155-mm M114	A	6	2125	28.7	424
155-mm M109	A	6	2929	28.9	428
155-mm M109A1	A	6	2929	28.3	412
8-inch M110	A	5	2927	30.0	469
175-mm M107	A	1	2924	25.5(TOF)	296

☐ ***DETERMINE FIRING DATA FOR BATTERIES B AND C***

30 B-8(MASS FIRE) SM; 23; ENTER

NOTE: This step places the adjusted target into Batteries B and C.

☐ ***OBTAIN FIRE FOR EFFECT DATA FOR BATTERY B***

31 TRIG

DISPLAY

	BTRY	*CHG*	*DF*	*TI*	*QE*
105-mm M101A1	B	7	2684	29.3	456
105-mm M102, M108	B	7	3084	28.2	415
155-mm M114	B	6	2281	25.9	385
155-mm M109	B	6	3084	26.0	389
155-mm M109A1	B	6	3084	25.5	375
8-inch M110	B	5	3083	27.0	424
175-mm M107	B	1	3082	22.4(TOF)	253

☐ ***OBTAIN FIRE FOR EFFECT DATA FOR BATTERY C***

32 Battery C button

33 TRIG

DISPLAY

	BTRY	*CHG*	*DF*	*TI*	*QE*
105-mm M101A1	C	7	2567	28.9	449
105-mm M102, M108	C	7	2967	27.8	408
155-mm M114	C	6	2164	25.5	380
155-mm M109	C	6	2967	25.7	384
155-mm M109A1	C	6	2966	25.2	369
8-inch M110	C	5	2965	26.6	418
175-mm M107	C	1	2962	22.6(TOF)	259

OBSERVER SURVEILLANCE: *END OF MISSION, ENEMY DISBURSED, ESTIMATE THREE CASUALTIES*

☐ ***TERMINATE THE MISSION FOR BATTERY C***

34 E-1(EOM) SM; 0

NOTE: Residuals in the FADAC apply to ICM only. If HE residuals are desired, proceed to step 41.

☐ ***TERMINATE THE MISSION FOR BATTERY A***

35 Battery A button; perform step 34.

☐ ***TERMINATE THE MISSION FOR BATTERY B***

36	Battery B button; perform step 34.	

☐ ***ENTER HE RESIDUALS FOR BATTERY A***

37	Battery A button	
38	F-6(DF CORR)	SM; appropriate charge (step 8); ENTER; deflection correction; ENTER
39	F-7(TIME CORR)	SM; appropriate charge (step 8); ENTER fuze correction; ENTER

NOTE: Range K must be entered if corrections for deflection and/or time have been entered in F-6 or F-7.

40	F-8(RANGE/K)	SM; appropriate charge (step 8); ENTER range K; ENTER

☐ ***ENTER HE RESIDUALS FOR BATTERY B***

41	Battery B button; repeat steps 37 through 41 using Battery B data.	

☐ ***ENTER HE RESIDUALS FOR BATTERY C***

42	Battery C button; repeat steps 37 through 41 using Battery C data.	

☐ ***TERMINATE THE MISSION***

43	Depress appropriate battery button.	
44	E-1(EOM)	SM; 0

H-10. Battery Fire for Effect Mission — Shift From Known Point, High Angle (PD/VT)

a. Known Data (para H-9).

b. Fire Mission and Fire Order.

(1) CALL FOR FIRE: *B26 THIS IS B32, FIRE FOR EFFECT SHIFT, OVER AB401, DIRECTION 6200, RIGHT 400, DROP 200, OVER TROOPS DIGGING IN RAVINE, VT, OVER.*

NOTE: AB401 is stored in file 3; 175-mm will not be used in this mission.

(2) FIRE ORDER: *CHARLIE, HIGH ANGLE, FOUR ROUNDS*

Table H-11. Battery Fire for Effect Mission — Shift From Known Point, High Angle — (PD/VT)

☐ Task	Step	Activate button-matrix location	Activate or type-keyboard location
☐ *SELECT PROPER BATTERY*			
	1	Battery C button	
☐ *LOCATE TARGET BY SHIFT FROM A KNOWN POINT*			
	2	A-4(TGT RECALL)	SM; 3; ENTER
		45500 43300 00396	
	3	A-5(OT DIR)	SM; 6200; ENTER
	4	A-6(RIGHT/LEFT)	SM; RIGHT 400; ENTER
	5	A-7(ADD/DROP)	SM; DROP 200; ENTER
☐ *APPLY APPROPRIATE OVERRIDES*			
	6	B-2(HI ANGLE)	SM; 0; ENTER
	7	B-6(FUZE TYPE)	SM; VT fuze flag (tables G-2 through G-5); ENTER
☐ *DETERMINE FIRING DATA*			
	8	COMPUTE	

DISPLAY

	CHG	*DF*	*TI*	*QE*
105-mm M101A1	7	2711	64.0	1138
105-mm M102, M108	7	3123	63.0	1133
155-mm M114	6	2298	69.0	1195
155-mm M109	6	3136	69.0	1196
155-mm M109A1	6	3142	68.0	1192
8-inch M110	4	3073	53.0	1013

OBSERVER SURVEILLANCE: *END OF MISSION, ESTIMATE 15 CASUALTIES*

☐ ***TERMINATE THE MISSION***

	9	E-1(EOM)	SM; 0

H-11. Immediate Suppression (HE/WP)

a. Known Data (para H-9).

b. Fire Mission and Fire Order.

(1) CALL FOR FIRE: *THIS IS B32, IMMEDIATE SUPPRESSION, GRID 503424, HE AND WP, OVER.*

(2) FIRE ORDER: *BRAVO, THREE ROUNDS*
BRAVO, HE, THREE ROUNDS (175-mm, 8-inch).

(3) VCO DATA: *ALTITUDE 412.*

Table H-12. Immediate Suppression — (HE/WP)

☐ Task	Step	Activate button-matrix location	Activate or type-keyboard location
☐ ***SELECT PROPER BATTERY***			
	1	Battery B button	
☐ ***LOCATE THE TARGET***			
	2	A-1(TGT EAST)	SM; 50300; ENTER
	3	A-2(TGT NORTH)	SM; 42400; ENTER
	4	A-3(TGT ALT)	SM; 412; ENTER

NOTE: 8-inch and 175-mm fire HE-PD only.

☐ ***DETERMINE HE FIRE COMMANDS***

	5	COMPUTE

DISPLAY

	CHG	*DF*	*TOF*	*QE*
105-mm M101A1	7	2264	38.4	579
105-mm M102, M108	7	2667	38.6	582
155-mm M114	7	1855	28.6	324
155-mm M109	7	2658	29.0	332
155-mm M109A1	7	2659	28.6	324
8-inch M110	6	2657	30.5	386
175-mm M107	1	2653	28.8	339

NOTE: 175-mm and 8-inch data is complete.

6	B-1(CHG)	SM; HE charge; ENTER
7	B-5(PROJ TYPE)	SM; WP flag (tables G-2 through G-5); ENTER
8	COMPUTE	

DISPLAY	CHG	DF	TI	QE
105-mm M101A1	7	2263	38.1	577
105-mm M102, M108	7	2666	38.3	578
155-mm M114	7	1855	28.7	326
155-mm M109	7	2658	29.0	334
155-mm M109A1	7	2659	28.6	326

OBSERVER SURVEILLANCE: *END OF MISSION, SAGGER NEUTRALIZED, ESTIMATE TWO CASUALTIES.*

☐ ***TERMINATE THE MISSION***

9	E-1(EOM)	SM; 0

Section II. Survey

H-12. General

The problems presented in this section represent common situations in which FADAC is used for survey. Matrix overlay 2 (fig G-2) is used to solve the survey problem, but in transferring data for use with the cannon matrix, overlay 1 is used.

H-13. Traverse Survey

a. Known Data.

SCP	44963.61 31694.50
Altitude	418.8
Azimuth SCP-TS 1	5598.1 mils
Distance SCP-TS 1	918.06 meters
Vertical angle SCP-TS 1	-2.6 mils
Azimuth TS 1 — TS 2	692.5 mils
Distance TS 1 — TS 2	1121.87 meters
Vertical angle TS 1 — TS 2	-4.4 mils
Azimuth TS 2 — TS 3	5858.7 mils
Distance TS 2 — TS 3	995.08 meters
Vertical angle TS 2 — TS 3	-3.3 mils
Azimuth TS 3 — BC	5008.3 mils
Distance TS 3 — BC	1120.62 meters
Vertical angle TS 3 — BC	-2.5 mils

b. Situation. The survey officer brings the field notes containing the known data to Battery A position. The FADAC operator is directed by the FDO to compute the coordinates of the battery center and to record the coordinates of the various stations of the traverse survey.

Table H-13. Traverse Survey

Phase	Step	Activate button-matrix location	Activate or type-keyboard
☐ ***OBTAIN COORDINATES AND ALTITUDE OF TRAVERSE STATION 1***			
	1	C-1(OBS EAST)	SM; 44963.61; ENTER
	2	C-2(OBS NORTH)	SM; 31694.50; ENTER
	3	C-3(OBS ALT)	SM; 418.80; ENTER
	4	C-4(OBS DIR)	SM; 5598.10; ENTER
	5	C-5(OBS HORIZ DIST)	SM; 918.06; ENTER
	6	C-7(OBS VERT ANGLE)	SM; -2.6; ENTER
	7	D-8(COMPT TRAV)	SM

44313 32342 417

☐ ***OBTAIN COORDINATES AND ALTITUDE OF TRAVERSE STATION 2***

8	C-4(OBS DIR)	SM; 692.50; ENTER
9	C-5(OBS HORIZ DIST)	SM; 1121.87; ENTER
10	D-8(COMP TRAV)	SM
11	C-7(OBS VERT ANGLE)	-4.40

45019 33215 412

☐ ***OBTAIN COORDINATES AND ALTITUDE OF TRAVERSE STATION 3***

12	C-4(OBS DIR)	SM; 5858.70; ENTER
13	C-5(OBS HORIZ DIST)	SM; 995.08; ENTER
14	C-7(OBS VERT ANGLE)	SM; -3.30; ENTER
15	D-8(COMP TRAV)	SM

44514 34073 409

☐ ***OBTAIN COORDINATES AND ALTITUDE OF BATTERY CENTER***

16	C-4(OBS DIR)	SM; 5008.30; ENTER
17	C-5(OBS HORIZ DIST)	SM; 1120.62; ENTER
18	C-7(OBS VERT ANGLE)	SM; -2.50; ENTER
19	D-8(COMP TRAV)	SM

43417 34300 00406

c. Discussion. The coordinates and altitude displayed during the process of computing the survey are expressed values and are displayed to the nearest meter. If, for some reason, accuracy is desired to the nearest hundredth of a meter, recall the observer easting, northing, and altitude, in turn, prior to computing a new traverse station.

H-14. Zone-to-Zone Transformation

a. Known Data.

(1) Local grid zone number 15S.

(2) Adjacent grid zone number 14S.

(3) Latitude: Northern hemisphere.

(4) Map spheroid: Clarke 1866.

(5) Enemy position: Zone 14S, OP 75243 35474 (the lower left corner coordinates of the OP 100,000 meter square in grid zone 14S is 600 000 38000 000).

(6) Observer — target direction: 540 mils.

(7) Enemy position altitude: 567 meters.

b. Situation. The grid location of an enemy position and the observer-target direction were reported by an observer using a map in UTM grid zone 14S. The fire direction data currently being used in FADAC is referenced in UTM grid zone 15S. The requirement is to transform the UTM grid zone 14S coordinates to the UTM grid zone 15S data and store the results as the location of target number 4.

Table H-14. Zone-To-Zone Transformation

☐ Phase Step	Activate button-matrix location	Activate or type-keyboard location
☐ ***MATRIX TWO PORTION***		
1	E-1(STA EAST)	SM; 675243; ENTER
2	E-2(STA NORTH)	SM; 3835474; ENTER
3	E-3(STA SPHERE)	SM; 1 (flag for Clarke 1866 spheroid); ENTER
4	E-4(STA AZ)	SM; 540; ENTER
5	E-5(STA ZONE)	SM; +14; ENTER
6	E-6(TRANS TO ZONE)	SM; +15; ENTER
7	E-8(COMP ZONE TO ZONE)	SM; 1

NOTE: The flag indicates the station as a target location. The transposed grid 25261 41419 and direction 601 mils will be displayed and stored in matrix locations A-1(TGT EAST), A-2(TGT NORTH), and A-5(OT DIR) on matrix 1.

☐ Phase Step	Activate button-matrix location	Activate or type-keyboard location
☐ ***MATRIX ONE PORTION***		
8	A-3(TGT ALT)	SM; 567; ENTER

NOTE: The target altitude must be obtained from the VCO map and entered.

☐ Phase Step	Activate button-matrix location	Activate or type-keyboard location
9	E-3(TGT STORE)	SM; 4; ENTER

H-15. Azimuth by Altitude

a. Known Data.

RADAR LATITUDE: (+)34° 39″ 48″
GRID DECLINATION: +6.0 mils
STAR NO: 64 (Vega)
STAR ALTITUDE: (-) 588.1 mils
STAR DECLINATION: (+) 688.90 mils
HOR ANGLE (MARK TO STAR): 969.7 mils

NOTE 1: The grid declination is preceded by a plus (+) sign if grid north is right of true north or a minus (-) sign if left of true north.

NOTE 2: The corrected observed altitude of the star/sun is preceded by a plus (+) sign if the body is east of the observer, or a minus (-) sign if west of the observer.

b. Situation. The battalion survey has completed an astronomic observation for a proposed radar site orientation. Radar position was map spotted until such time that position survey could be completed. The survey officer brought the field notes of the observation into the fire direction center. The requirement is to derive an azimuth to an OL for orienting the radar.

Table H-15. Azimuth by Altitude

	Step	Activate button-matrix location	Activate or type-keyboard location
	1	F-1(STA LAT)	SM; +34.39.48; ENTER
A	2	F-2(STAR ALT)	SM; -588.1; ENTER
	3	F-3(STAR DECL)	SM; +688.90; ENTER
	4	F-4(HORIZ ANGLE)	SM; 969.7; ENTER
	5	F-5(GRID DECL)	SM; +6.0; ENTER
	6	F-8(COMP AZ BY ALT)	SM

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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., *26 August 1970*

OPERATION OF THE GUN DIRECTION COMPUTER M18, CANNON GUNNERY APPLICATION

* This manual supersedes FM 6-3-1, 14 June 1968.

APPENDIX E

CANNON PROGRAM TAPES

★The following items are contained in Revision 4, Cannon Machine Program Tape Kit, Federal Stock Number (FSN) 1290-466-0140. The set of addendum tapes is packaged separately and may be requisitioned as a set identified by FSN 1290-466-0142. The basic cannon program tape is packaged separately and may be requisitioned as a separate item identified by FSN 1290-466-0141. The basic cannon program tape incorporates the ballistic data for the 105-mm howitzers M102 and M108 and the 155-mm howitzer M109.

★*Item*	*Part number*
Basic cannon program tape	8213330-80
Addendum tapes:	
105-mm How, M101A1/105-mm How M102, M108	8213315-81
105-mm How M101A1/155-mm How M114A1	8213315-82
105-mm How M101A1/155-mm How M109	8213315-83
105-mm How M102, M108/155-mm How M114A1	8213315-84
105-mm How M102, M108/155-mm How M109	8213315-85
155-mm How M109/155-mm How M114A1	8213315-86
8-in How M110/155-mm How M114A1	8213315-87
175-mm G, M107/155-mm How M114A1	8213315-88
155-mm M109/8-inch How M110	8213315-89
155-mm M109/175-mm G, M107	8213315-90
8-inch How M110/175-mm G, M107	8213315-91
105-mm How M101A1/8-inch How M110	8213315-92
105-mm How M102, M108/8-inch How M110	8213315-93
105-mm How M101A1/175-mm G M107	8213315-94
105-mm How M102, M108/175-mm G M107	8213315-95
Clear hot storage tape	8213315-96
Repetitive test routine	8213315-97
Mechanical tape reader	8213315-98

FM 6–40–3 OPERATION OF THE GUN DIRECTION COMPUTER M18, CANNON GUNNERY APPLICATION—1970